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WEDNESDAY, July 6th. Captain S. M. EARDLEY-WILMOT, R.N., on "The Dimensions of Modern War Ships."

FRIDAY, July 8th. Colonel The Hon. H. G. L. CRICHTON (Com. Hants Yeomanry), on "Saddles."

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[Monthly Issue.]

Friday, May 13, 1892.

MAJOR-GENERAL R. N. DAWSON-SCOTT, Commandant, School of Military Engineering, Chatham, Member of Council, in the Chair.

MODERN AERIAL NAVIGATION.

By Captain J. D. FULLERTON, R.E.

SYLLABUS.

Introductory remarks and division of the subject.

SECTION I.—*Ballooning or Aerial Navigation by means of Machines lighter than the Air.*

Characteristics of this system.—Successful attempts at propelling balloons.—Giffard's dirigible balloon.—Dupuy de Lôme's dirigible balloon.—The dirigible balloon designed by the brothers Tissandier.—"La France."—Campbell's air ship.—Professor Carl Meyer's aerial bicycle.—Proposed balloon for war purposes.—The method of calculating the power, speed, &c., of dirigible balloons.—General remarks on dirigible balloons.

SECTION II.—*Aviation or Aerial Navigation by means of Machines heavier than the Air.*

Characteristics of this system.—The theory of aeroplanes.—The motion of an aeroplane through the air.—Longitudinal stability.—Crosswise stability.—Remarks on large aeroplanes.—The bird, and theories of its flight.—Wing motion.—Movements during flight.—Power, speed, &c., of a bird in motion.—Mons. Marey's views.—Mr. Chanute's views.—Mons. Richet's views.—Possibilities of flight in man.—Successful flying machines.—Hargraves model.—Mons. Adler's machine.—Machine proposed by Mr. Maxim.—Motors and methods of propulsion.—The method of calculating the speed, power, &c., of machines of the aeroplane type.—General remarks on aviation.

Concluding remarks.

Introductory Remarks.

THE subject which I propose to bring to your notice to-day, viz., "Aerial Navigation," is one of the very greatest importance to mankind in general, as there can be no possible doubt that if the power of moving safely and expeditiously through the air be successfully attained, great changes affecting all classes and all interests will take place.

Hitherto, unfortunately, in this country aerial navigation has been looked upon, to put it mildly, with the deepest suspicion, and it is no exaggeration to say that the terms "aeronaut" and "lunatic" are at present considered as more or less synonymous.

My object to-day is to show you that the science of aeronautics is based upon simple rules and common sense, and not upon wild and vague theories opposed to all principles of nature. It is only within the last few years that the subject has been scientifically studied, and I believe that, as the result of that study, the long wished for solution of the problem is at last within our reach.

What I particularly wish to do to-day is not so much to advocate any particular system of flight, as to explain the latest ideas on the subject, and to leave you to judge for yourselves as to their possible application for practical purposes.

Division of the Subject.

Aerial navigation is divided into two distinct branches, viz.:—

1. Ballooning, or navigation by means of machines lighter than air;
2. Aviation, or navigation by means of machines heavier than air;

and as these two branches depend upon diffierent principles, I propose to explain them separately.

SECTION I. BALLOONING, OR AERIAL NAVIGATION BY MEANS OF MACHINES LIGHTER THAN THE AIR.

Characteristics of this System.

The chief characteristics of this system are:—

1. That the weight to be moved is floated in the air, by means of a balloon or envelope, filled with a gas lighter than the air—the principle being, of course, exactly the same as that by which a ship floats on the water.

2. That the forms of the balloon, car, &c., are such as to offer the smallest possible resistance. For this reason the envelope is usually made spindle-shaped.

3. That owing to the weight being taken, as above explained, it is only necessary to provide a propulsive force sufficient to overcome the horizontal resistance.

Fig. 8 shows an ordinary type of dirigible balloon. It will be seen

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Vol. XXXVI

FIG. 1. GIFFARD'S BALLOON.

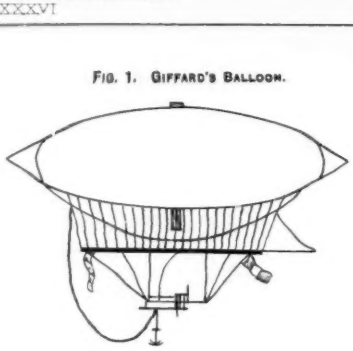

FIG. 2. BALLOON OF DUPUY DE LÔME.

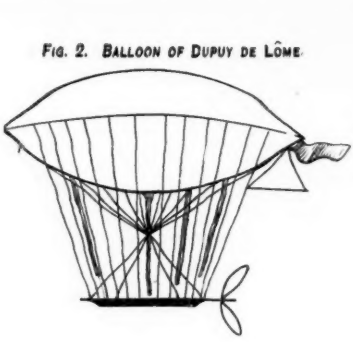

FIG. 3. TISSAUDI

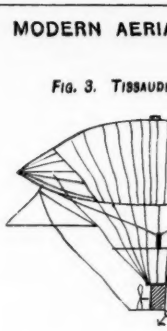

FIG. 6. CAMPBELL'S AIR SHIP.
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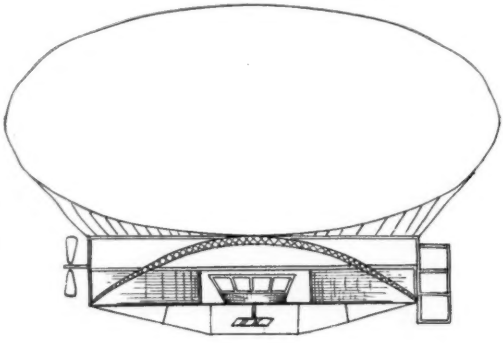

FIG. 7. PROFESSOR C. MEYER'S AERIAL BICYCLE.

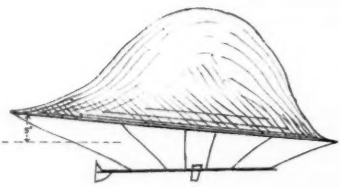

FIG. 12. T

FIG. 11. THEORY OF BIRD MOTION.

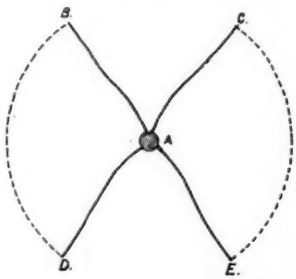

FIG. 13.

FIG. 16. DIAGRAM OF GULL'S MOVEMENTS.

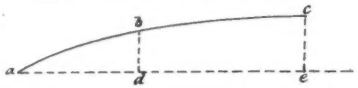

FIG. 18. ADER'S FLYING MACHINE.
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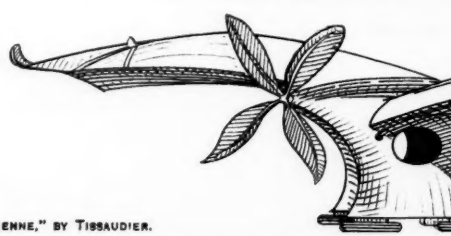

FIG. 17. HARGREAVES' FLYING MACHINE.
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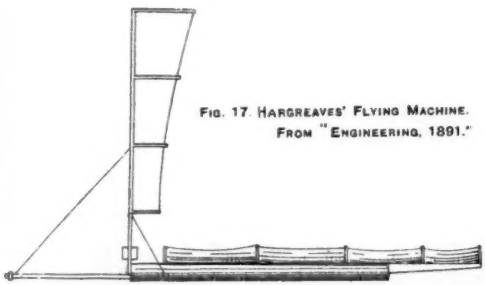

FIGS. 1, 2, 3, AND 4 FROM "LA NAVIGATION AERIENNE," BY TISSAUDIER.

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ERIAL NAVIGATION.

SSAUDIER'S BALLOON.

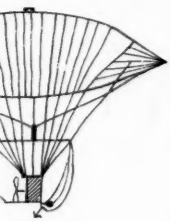

FIG. 4. "LA FRANCE."

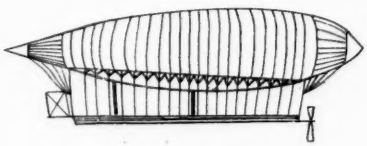

FIG. 5. SCREW OF "LA FRANCE."
FROM "REVUE DE L'AERONAUTIQUE."

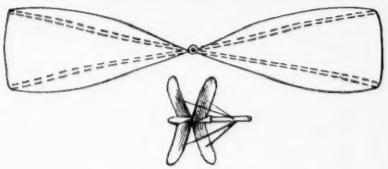

FIG. 8. PROPOSED WAR BALLOON.

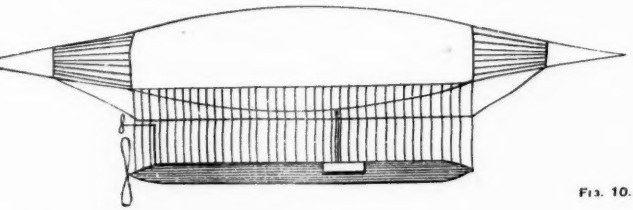

FIG. 9. THEORY OF AEROPLANES.

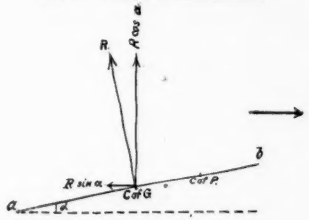

FIG. 10. CROSSWISE STABILITY OF AEROPLANES.

12. TRAJECTORY OF THE POINT OF THE WING OF THE BUZZARD.

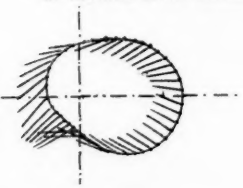

FIG. 14. ROWING FLIGHT OF THE GULL.

FIG. 15. PART OF TRAJECTORY OF A GULL.

IG. 13. BIRD ALIGHTING.

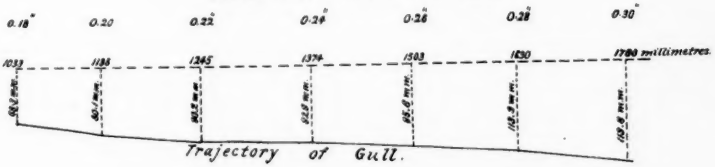

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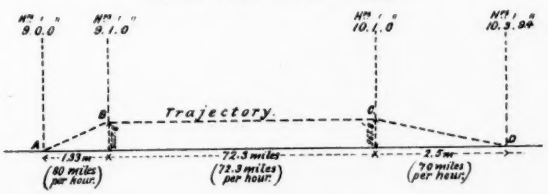
FIG. 19. TRAJECTORY OF AEROPLANE.



FIGS. 12, 13, 14, AND 15 FROM "LE VOL DES OISEAUX," BY M. MAREY.

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that the envelope is spindle-shaped, and that the car is attached to it by means of a specially-designed jacket with rope attachments, &c.

Successful Attempts at Propelling Balloons.

From time to time various persons have constructed small model balloons, and worked them successfully at a slow pace.

In 1833 Rufus Porter, an American, constructed a model 22 feet long, and 4 feet in diameter. The propulsive power was a compact little steam engine, and it appears that the machine actually moved at a somewhat rapid rate when exhibited at New York and Washington. In 1850 Mons. Jullien exhibited a model at the Hippodrome in Paris; it was fish-shaped, and weighed 1,160 grams, the content of the envelope being 1,203 c.dm. The gas employed was pure hydrogen, and the machine was forced along by a spring working two small screws. It appears to have been fairly successful, but eventually broke down from being overweighted. The first really successful attempt, however, on a large scale, appears to have been that of Mons. Henri Giffard, shown in Fig. 1.

Giffard's Balloon.

The principal dimensions were; length 44 m., largest diameter 12 m., cubic content 2,500 c.m., giving for pure hydrogen a lifting power of 2,800 kilos., and for coal-gas (which was actually used) 1,800 kilos. There was a long wooden bar, 20 m. in length, to which the car and its appurtenances was hung 6 m. lower down. The car itself was little more than a wooden platform with wheels, so as to allow of the machine running easily along the ground, if it came down with any horizontal velocity. The boiler was vertical, and surrounded with a sheet-iron casing to prevent any flame reaching the coal-gas. The funnel pointed downwards, and the whole apparatus was very ingeniously designed.

The screw had 3 blades and a diameter of 3·40 m.; with 110 revolutions it gave 3 F.H.P. The weights were as follows:—envelope with valve, 320 kilos.; net, 150 kilos.; beam, suspending ropes, &c., 300 kilos.; machine and boiler empty, 150 kilos.; water and coke in boiler at time of starting, 60 kilos.; car with wheels, coal and water tanks, 420 kilos.; anchor rope, 80 kilos.; one passenger, 70 kilos.; spare, 258 kilos; total, 1,800 kilos. The ascensional force was 10 kilos., the remainder of the spare 258 kilos. being utilized for coal and water.

A trial was made on the 24th September, 1852; there was a strong wind blowing at the time, and although the machine could not overcome the wind resistance, it managed to keep fairly well up to it, and there was no difficulty in steering in any direction. To Mons. Giffard undoubtedly belongs the credit of having been the first person to manœuvre a balloon in the air, with any sort of success.

The next successful attempt was that of

Dupuy de Lôme.

This balloon is shown in Fig. 2. During the siege of Paris in October, 1870, the Government of National Defence entrusted the construction of a dirigible balloon to Mons. Dupuy de Lôme, but unfortunately it was not completed until the siege was over. The principal dimensions were: length, 36 m.; largest diameter, 14·84 m.; cubic content, 3,400 c.m.; screw, 9 m. in diameter. Pure hydrogen was used for inflating the envelope; the motive power was furnished by eight men. There was a very ingenious arrangement for causing the balloon to rise or fall, and for keeping the envelope to its proper form, in the shape of a small balloon inside the large one. This small balloon was filled with atmospheric air, and had a capacity of about $\frac{1}{10}$th of the large one. To raise the machine, air was drawn out of this balloon, thus making the whole affair lighter, while to lower it, air was forced in. In this manner a rising power of 864 m. was obtained. Another point about the balloon was the manner in which the car was hung; all the suspending ropes were collected at a point above the car, the idea being to render the machine more stable, and to stop swaying about.

A trial took place on 2nd February, 1872, and was successful, a speed of about 2·82 m. per second, or $10\frac{1}{4}$ km. per hour, having been attained, on a still day, with $27\frac{1}{2}$ revolutions per minute of the screw. It was of course obvious that man power was not sufficient for practical work, and Mons. de Lôme proposed using an 8 F.H.P. engine, but the French Government does not appear to have done anything further in the matter.

The Balloons designed by the Brothers Tissaudier.

At the Paris Exhibition of 1881, the brothers Tissaudier showed a small dirigible balloon, of a type very similar to that of Giffard's. This balloon had a small electric motor and attained a speed of 3 m. per second. Encouraged by these results, they constructed a large balloon shown in Fig. 3, the principal dimensions of which were: length, 28 m.; largest diameter, 9·20 m.; cubic content, 1,060 c.m. There was an automatic valve in the lower part of the envelope. The screw had two blades, diameter 2·80 m., and made 180 to 200 revolutions per minute. The motor was a Siemens' dynamo, having a force of 100 kilogram-meters, and a weight of 45 kilos.; the battery being a bichromate one of special construction. The weights were: envelope with valve, 170 kilos.; jacket, rudder, suspending cords, 70 kilos.; braces, 34 kilos.; car (made of bamboo and wickerwork) 100 kilos.; motor screw and battery with materials for $2\frac{1}{2}$ hours' consumption, 280 kilos.; anchor and guide rope, 50 kilos.; two passengers with instruments, 150 kilos.; ballast and spare, 396 kilos.; total lift, 1,250 kilos. The balloon was inflated with hydrogen. Ascents were made in 1883 and 1884, with very fair success; there was no difficulty in steering, but the highest speed attained did not probably exceed

4 m. per second. With such a small H.P., viz., $1\frac{1}{2}$ F.H.P., this was not surprising. Want of funds seems to have prevented the brothers Tissandier from doing any further work in the ballooning line.

"*La France.*"

Fig. 4 shows "La France," the large dirigible balloon built by the French Military Engineers Captains Renaud and Krebs at Chalais-Meudon. The principal dimensions were: length, 50·42 m.; diameter, 8·40 m.; content, 1,864 c.m. The largest diameter was at a point about $\frac{1}{5}$ length from the front of the balloon, instead of being at the centre. The screw, which had a diameter of 7 m. (see Fig. 5), was placed in front, and the 12 F.H.P. engine gave a force of $8\frac{1}{2}$ F.H.P. on the shaft of the screw. There was a small balloon inside the envelope, as in Dupuy de Lôme's machine, and a movable weight was used for adjusting the equilibrium of the whole apparatus. The car was 33 m. long, and 2 m. high; the object of the great length being to ensure stability. The weights were as follows:—Envelope and small balloon, 369 kilos.; jacket and net, 127 kilos.; car complete, 452 kilos.; rudder, 46 kilos.; screw, 41 kilos.; motor, 98 kilos.; other gear, 47 kilos.; shaft of motor, 30·5 kilos.; battery, &c., 435·5 kilos.; passengers, 140 kilos.; ballast, 214 kilos.; total, 2,000 kilos.

Ascents were made in 1884 and 1885 as follows:—

9th August, 1884.—Speed 4·58 m. per second; 42 revolutions of screw per minute. The balloon returned safely to Chalais-Meudon.

12th September, 1884.—Speed 4·43 m. per second; 50 revolutions. On this occasion there was a breakdown of the battery, and the descent was made at Velizy.

8th November, 1884.—Speed 6·00 m. per second; 55 revolutions. The balloon returned safely to Chalais-Meudon.

8th November, 1884.—Speed 3·82 m. per second; 35 revolutions.

25th August, 1885.—Speed 6·00 m. per second; 55 revolutions. Wind was too strong; descent at Villacoublay.

22nd September, 1885.—Speed 6·00 m. per second; 55 revolutions. The balloon returned safely to Chalais.

23rd September, 1885.—Speed 6·22 m. per second; 57 revolutions. The balloon returned safely to Chalais.

The general results were fairly successful, but no great speed could be obtained.

Captain Renaud states that the resistance to horizontal motion was much more than he had calculated, it having reached 22·8 kilos. for a speed of 5·50 m. per second. There was no difficulty in steering the machine; but on the first trial it pitched slightly; there does not appear to have been any difficulty about this afterwards. The speeds given above are, of course, for calm weather only.

Campbell's Air Ship.

In 1889, Mr. Campbell, an American, invented the air ship shown in Fig. 6. The length of the balloon was 60 feet, and, although spindle-shaped, the points were blunted. The rising and falling of the machine was managed by the vertical screw in the centre, there being not quite sufficient gas to lift the weight. One man could work both the vertical and horizontal propellers. The preliminary trials were successful, the machine moving forward at a slow pace; but on 16th July, 1889, when Professor Hogan went up in it, the vertical screw fell off, and entirely disarranged the equilibrium. This, of course, ruined the machine, which drifted out to sea and was never heard of again. The principle of the machine was good enough, but it could never have gone any pace, as the shape was bad and the power insufficient to drive it.

Professor C. Meyer's Aerial Bicycle.

The rather extraordinary looking machine represented in Fig. 7 is the aerial bicyle designed by Professor Carl Meyer. The figure is only a rough sketch, but will show the general principle of the apparatus. A short account of it appears in Fores' "Sporting Magazine," 1890 and 1891, and the "Graphic" had a picture of it in August last.

The envelope is something in the shape of a cocked hat, the lower part of which is inclined at an angle of about 5° with the horizon. The propeller is rather a peculiar one, with a right and left, instead of a circular motion. The whole machine is made very light, the bicycle framework weighing, I believe, only 29 lbs.

The mode of starting is as follows:—The amount of gas in the envelope not being quite sufficient to raise the weight, the rider gets on the seat, and pushes himself up into the air, by pressing against the ground with his foot; he then works the pedals as hard as he can, and the machine moves upwards and forwards.

The explanation given in the article above quoted is that the back pressure of air from the propeller strikes the under surface of the balloon and forces it up. This, in my opinion, is incorrect; what I think really happens is that the under surface of the envelope acts as an aeroplane, and the moment any speed is got up the air furnishes a pressure, which forces the machine up. If this is the case, it is a most ingeniously designed apparatus. The steering is done by throwing the weight of the body to the left or right, something after the fashion of a bird. I will explain further on the theory of the action of an aeroplane.

It is of course very difficult, without having the exact dimensions, to calculate the power required to drive this machine; but from rough calculations I have made, I think the resistance for a speed of about 10 miles per hour would be about 3 lbs. A two-bladed screw propeller about 3 feet in diameter would give this thrust, if the power was about $\frac{1}{10}$ H.P. Such a force is just about what a man can

conveniently exert for several hours consecutively; for shorter periods he can, of course, do much more.

The upward pressure on the aeroplane would be about 3 lbs., quite sufficient for the purpose. As far as I can see, there is no reason why the machine should not work. Professor Meyer says he can go 10 miles an hour, without undue exertion.

I think a less eccentric form of envelope would be better; if it was spindle-shaped, and had a light aeroplane of bamboo and canvas over the head of the rider, the apparatus would probably be more manageable.

The next subject to be considered is the type of dirigible balloon likely to be suitable for war purposes.

Description of proposed War Balloon.

The requirements of such a balloon are:—

1. That it should be able to carry three or four passengers, a supply of explosive shells, and a machine gun or two.

2. That it should be able to travel at the rate of about 30 miles an hour on a still day; this speed would enable it to keep up with almost any war-ship now afloat, on more than half the days of the year.

Fig. 8 shows a balloon which would, I think, meet the above requirements.

The Envelope.—Spindle-shaped, 30 feet in largest diameter; length, 240 feet. General shape, a trachoid of revolution, the object being to get easy "entrance curves." The valves for letting out gas should be so arranged as to be easily opened and shut from the car.

Jacket and Netting.—This should be light, but strong, and should be very carefully designed, as the stability of the balloon depends very much upon it.

Car.—Length, 120 feet; breadth and height, 6 feet; ends pointed so as to offer less resistance.

Propeller.—Two screws 18 feet in diameter.

Engines.—These would have to be very carefully designed, great attention being paid to lightness.

Rudder.—This should be a small screw in rear, above the propellers. It should be so arranged that its shaft can be moved from left to right. The thrust of the screw can thus be utilized to change the direction of the balloon.

Equilibrium Adjuster.—An arrangement similar to that used by Captains Renaud and Krebs in "La France" might be used with advantage.

Ballast.—Instead of using sand, air might be compressed in a tank. When it is required to ascend, air could be let out; while in descending, air could be pumped in.

The Method of Calculating the Dimensions, Speed, &c.

In the "Proceedings of the Institute of Civil Engineers," vols. lxvii and lxxxi, are two papers on "Aerial Navigation," by W. Pole, Esq.,

F.R.S., M.I.C.E. These are most important, as they are, as far as I can ascertain, the first attempt to calculate the speed, &c., upon really scientific principles. The whole theory of the subject is most carefully gone into, and I strongly recommend their perusal to anyone interested in the matter.

As regards the balloon shown in Fig. 8, I have worked out a set of formulæ, based, more or less, on Pole's paper, suited to the particular shape I advocate, and an account of them can be found in the "R.E. Journal" for February, 1891. The example calculated is as follows (see Fig. 8):—

Conditions.

Total weight, 5,400 lbs., approximately; general form as shown in the figure. Required the dimensions of the balloon, its speed, H.P., &c.

(*a.*) Assuming a diameter of 30 feet, and length 240 feet, the weight which the balloon can lift is found to be 5,437·26 lbs. This might be distributed as follows:—

	Lbs.
Envelope.....	700
Jacket and netting.....	300
Car, lines, rudder, &c.	600
Propeller and screw	200
Engines, water, fuel, &c.	1,800
Instruments	100
Anchor, spare ropes, &c.	150
Passengers	500
Explosives, ballast, &c.....	1,087
	5,437

(*b.*) The cubic content is 72,403 cubic feet.

(*c.*) The maximum theoretical height to which the balloon can rise = 5,425·47 feet.

(*d.*) The resistance to motion through the air is = 230 lbs. at 26·927 miles per hour.

(*e.*) The gross horse power required would be 20 H.P.; efficiency taken at 0·8.

(*f.*) The speed would be 26·9 miles per hour.

(*g.*) The weight of the engines would be about 90 lbs. per H.P. with four hours' coal and water. I will allude to the subject of weight of engines further on; at present I will only say that there should be no difficulty in building engines at this weight.

Remarks on Dirigible Balloons.

The above calculations give rather startling results, but I believe they give a very fair statement of the case as it now stands. I will, however, leave you to draw your own conclusions, and merely point out some of the advantages and disadvantages of balloons, from a

mechanical point of view, it being, I think, generally admitted that for military purposes a balloon capable of moving safely and expeditiously through the air would be most useful.

Advantages.

1. Ascending and descending can be very easily managed by letting out ballast in the shape of compressed air. This air can be obtained at any height without difficulty.

2. No lifting power is required from the engines, only a propelling power; consequently very much less powerful and less expensive engines can be used. This is, of course, a very important matter.

Disadvantages.

1. Floating about in the air, entirely dependent on a bag of gas, is not a very safe proceeding.

2. It is doubtful whether, at very high speeds, the form of the balloon would not be altered, and consequently pace lost, owing to the pressure of the air. I think, however, that at speeds like 30 or 40 miles per hour this might be obviated, either by using a small balloon inside the large one, as before explained, or by making use of bamboo stiffeners, as proposed by General Hutchinson.

3. The difficulty of getting sufficiently light motors. This, of course, applies to all methods of aerial navigation.

4. The expense. This no doubt would be fairly heavy, but it must be recollected that a war balloon of the above type, if it was at all successful, would save its cost over and over again.

With these remarks I shall conclude the consideration of aerial navigation by means of machines lighter than air, and proceed to discuss "aviation," which I myself believe to be the most important of the two branches of the subject.

Section II.—Aviation, or Navigation by means of Machines heavier than the Air.

Characteristics of this System.

The chief characteristics of this system are:—

1. That the machine used is heavier than the air.

2. That a large supporting surface, either in the form of wings, or in the form of an aeroplane, is used to carry the weight.

3. That the lifting or supporting power of this surface is dependent upon its velocity and the angle of inclination which it makes with the horizon, increasing as the velocity or angle increases, and decreasing as they decrease.

4. That the horizontal resistance to motion depends upon the velocity and angle of inclination, in the same manner as the lifting power does.

From these 3rd and 4th characteristics, the following very impor-

tant fact is deduced, viz.: that the higher the speed, the less the power required to drive the machine. For, by reducing the angle of inclination, the horizontal resistance and, consequently, the power is reduced, while, by using a high speed, loss of lifting power is compensated for.

Thus, a plane and car, weighing, say, 15,000 lbs., with a 4° inclination, moving at about 62 miles per hour, has to overcome a horizontal resistance = about 1,000 lbs. The same plane, with an inclination of 3° and a speed of 72 miles an hour, meets with a resistance = about 800 lbs. In other words, less power is required to drive it at 72 miles an hour than at 62 miles an hour. These figures are taken from the example worked out later on.

5. That the means of propulsion is either by wing movements, as in the case of a bird, or by a screw propeller, jet propulsion, or some such mechanical arrangement.

Before discussing possible flying machines of the aeroplane type, it is necessary to understand

The Theory of Aeroplanes.

Our knowledge of the principles governing the motion of planes through the air has, till the last two years or so, been somewhat vague; the fact being that the subject has, until quite recently, received little or no attention. As regards planes moving vertically through the air, numerous experiments have been made by Hutton, Newton, and others, the general result being that, for small speeds, the pressure per square foot on a surface moved vertically through the air varies as some function of the square of the velocity. Different formulæ have been proposed, but for the purposes of this lecture I will take the well-known one of Smeaton, viz.,

$$p = \frac{v^2}{200},$$

where p = pressure per square foot in lbs., and v = velocity of plane in miles per hour.

Next, as regards planes moving through the air at an angle.

Various experiments have been made, but the first really satisfactory formula appears to be that of Colonel Duchemin, of the French Engineers, who found that

$$P_\alpha = p\frac{2\sin\alpha}{1+\sin^2\alpha},$$

where P_α = normal pressure per square foot on the inclined plane,

α = angle of inclination of the plane with the horizon.

During the last few years, Professor Langley, of America, has, by means of very carefully-constructed apparatus, thoroughly investigated the subject, and his results agree almost exactly with those of Duchemin. A very interesting account of these experiments is given

in "Experiments in Aerodynamics," recently published, and I think we may take it that the subject has now been fairly well threshed out. Assuming Langley and Duchemin's formulæ to be fairly correct, I will now explain

The Motion of an Aeroplane through the Air.

Let *ab*, Fig. 9, represent the aeroplane or thin rectangular plate, inclined to the horizon at an angle α, and moving with any given velocity, in the direction shown by the arrow. Then R is the normal resistance of the air = $SP\alpha$, where S is the number of square feet of surface of the aeroplane.

Now R can be resolved into two components: R cos α opposing the weight W, and R sin α resisting the advance of the aeroplane. Leaving aside, for the moment, the fact that the forces R and W act at different points in the plane, we have:—

If R cos α is less than W, the aeroplane will move downwards, with the velocity due to the pressure $W - R \cos \alpha$.

If R cos α is greater than W, the aeroplane will move upwards, with the velocity due to the pressure $R \cos \alpha - W$.

If R cos α = W, the weight will be just supported and the aeroplane will move along, on the level, with the velocity corresponding to the value of R.

From the above it will be seen that it is easy to find out the weight which a given aeroplane, moving at a given velocity, will carry; for example, aeroplane 1 square foot, $\alpha = 2°$, velocity 60 miles per hour. By Langley and Smeaton's formulæ, the normal pressure R = 1·26 lbs., and resolving

$$R \cos \alpha = 1{\cdot}26 \text{ lbs. (since } \cos 2° = 1 \text{ nearly)};$$

and, consequently, the plane will carry 1·26 lbs., including its own weight.

Also the resistance R sin α = 0·043 lb.; and, consequently, the horse power required to drive the plane $= \frac{0{\cdot}043 \times 5{,}280}{33{,}000} = 0{\cdot}00688$ H.P.

Longitudinal Stability.

I noticed above that the forces R and W were not applied at the same point. The reason of this is, that the centre of pressure of an inclined plane moving through a fluid does not coincide with the centre of gravity of the plane. The rules for finding the position of pressure in cases of this sort are given very clearly by Mons. Dezewiecki, in a paper read by him before the Aeronautical Society of Paris in 1889. This very important paper, to which I shall allude further on, states that, for planes of this description, moving at very small angles of inclination, the centre of pressure is at a distance from the front edge of the plane equal to two-tenths of its length. In the case above quoted, therefore, the distance between

the centres of pressure and gravity will be $\frac{3}{10} \times 12'' = 3{\cdot}6''$, and must, of course, be taken into consideration. The best plan to do this appears to be, to shift the weights forward so that the vertical line through the centre of gravity coincides with the vertical line through the centre of pressure; in this way the machine will be longitudinally stable, and there will not be any tendency to tip back.

Crosswise Stability.

This is also important, and can be secured by making the plane in cross section somewhat as shown in Fig. 10.

Large Aeroplanes.

As regards large aeroplanes, such as those 50 feet by 100 feet in size, it cannot be said for certain that the pressures found by the above rules will be strictly in proportion to the extent of the surfaces, but they most probably are, and such will be considered to be the case in the calculations drawn up further on.

In the above remarks, I have only touched generally upon the more important parts of this subject. For further details, I must refer you to Professor Langley's "Experiments in Aerodynamics," and Monsieur Dezewiecki's paper, published in "L'Aéronaut," 1889.

I will now proceed to explain the motion of the best known flying machine at present, viz.:—

The Bird.

Up till quite recently, the generally accepted theory of the bird's motion has been that by flapping its wings it produced a force which lifted it and drove it along, somewhat as follows (Fig. 11):—

Let A be a cross section of the body of the bird, AB, AC, the position of the wings when at the beginning of the stroke; AD, AE, the positions at the end of the stroke; then it was considered that the wings acted as aeroplanes, moving with a velocity equal to that of the down stroke, the air pressures generated in this manner counterbalancing the weight, as soon as they were strong enough. It was admitted that the up strokes also produced air pressures, which would on this theory drive the birds down, but it was pointed out that there was a great difference between the strength of the upward and downward strokes, owing to the wing being in the former case convex, and in the latter concave. Speaking generally, it was the difference between the up and down air pressures which was the real motive power. The actual propulsion was supposed to be due to the fact that the forces above mentioned did not act in a vertical line, and that consequently there was a horizontal component which drove the bird along, and a vertical component which sustained it in the air.

This theory, however, does not appear to be correct. Mons. Dezewiecki's theory is as follows:—

1. A bird is simply an aeroplane of a peculiar shape, and having a peculiar kind of motor, and it is sustained in the air in exactly the same way as an aeroplane is.

2. A bird in full flight carries its plane, generally speaking, at an angle of about 2° or 3°.

3. The rules for aeroplanes apply generally to birds, making allowance for size of wings, &c.

4. At small angles, such as 2°, the resistance to horizontal motion (for small bodies) is very small indeed. The aeroplane alluded to above weighed about $1\frac{1}{4}$ lbs., and only required 0·006 H.P. to drive it at the rate of 60 miles an hour.

5. At the lower velocities, just after starting, owing to the steeper angle of inclination, greater power must be exerted by the bird, its object being to get up a high speed as quickly as possible, so as to utilize the air pressure as a lifting force.

6. The propelling force is due to the air escaping, or rather being forced under the wings backward. These streams of air act against the atmosphere, and propel the bird along.

I should add that Mons. Dezewiecki shows from an example that the usually accepted theory is quite wrong in the case of large birds, and that they cannot possibly work up sufficient air resistance to sustain their own weight.

Wing Motion.

There are probably few subjects which have been so much disputed over as the motion of a bird's wing in "rowing" or ordinary flight. The great difficulty in connection with the matter is to find out what really does occur, as the speeds of the birds and wings are so great that the eye does not readily grasp the motions. An immense amount of thought and labour has been spent by Mons. Marey, in making experiments on this subject, and in his most interesting book, called "Le Vol des Oiseaux," he has given us the results of these labours.

Fig. 12 shows the trajectory of the point of the wing of a buzzard in rowing flight (medium speed) and the approximate positions which the plane of the wing assumes during an up and down stroke. It will be noticed that the trajectory is elliptical, with the longer axis of the ellipse inclined downwards and forwards, and that in the second quarter of the ellipse the wing is distinctly driving the air backwards.

When a bird is in full flight, it is found, as might be expected, that the larger axis of the ellipse approaches more nearly to the vertical as the speed increases; while, on the other hand, at the commencement of flight, the axis is nearly horizontal.

Movements during Flight.

Our knowledge of the movements of birds during flight is by no means satisfactory, and many points in connection with the subject

are still much disputed. As regards "starting," it is pretty well certain that the smaller birds either give a vigorous jump in the air, so as to get clear of the ground, and then violently flap their wings, or throw themselves off a height, the object in both cases being the same, viz., to get up speed as quickly as possible, so as to get the benefit of the vertical component of the air pressure. Larger birds either throw themselves off a height, or run rapidly along the ground, jump into the air, and beat their wings violently.

"Stopping."—Fig. 13 shows a duck coming down. The method of using the wings, to prevent stopping too quickly, is well illustrated.

"Rowing Flight."—Fig. 14 shows the different positions of a gull, practising this kind of flight. Instantaneous photographs of their positions were taken by Mons. Marey, at intervals of $\frac{1}{50}$th second.

"Floating Flight."—I do not know exactly what name to give this description of flight, but I think "floating" expresses the facts of the case. It is practised when a bird suddenly stops "rowing," and is carried forward by the impetus left in it. Usually, the bird glides down an inclined plane of about 7° or 8°, with his wings held out horizontal; as long as he has any energy left, he can, by altering the plane of his wings, rise, fall, move right or left, &c.

"Sailing Flight."—There is a great deal of difference of opinion as regards "Sailing Flight," but all authorities seem to agree upon one point, viz., that it can only be practised in a high wind. The usual idea seems to be that the vertical component of the high wind (against the bird) forms a supporting force to hold the bird in the air; later theories are against this, and it is difficult to say which is correct.

"Turning Movements."—This is done by throwing the weight of the body towards the side to which it is intended to turn.

The Power, Speed, &c., of a Bird in Flight.

Numerous attempts have been made to estimate the power required to move a bird at any given velocity, and the estimates are most conflicting. Years ago, one author considered that a goose in full flight expended 200 H.P., whilst a recent calculation by Mr. Maxim shows that the goose would only expend 0·083 H.P. When "doctors differ" to such an extent as this, it is a little difficult to get at the truth; but I think, by describing to you the methods used by some of the abler modern experimentalists, you can get a very fair idea of the approximate power required for the different kinds of flight.

Mons. Marey's System.

The first really careful, scientific calculations appear to be those of Mons. Marey, who was assisted by Captain de Labouret, of the French Engineers. In his book, "Le Vol des Oiseaux," he goes very thoroughly into the subject, and his general method of investigation may be described as follows:—

A gull, carrying a small bright bead on his head, was made to fly

in front of a specially-constructed camera, and photographs of the bird in flight were taken at intervals of $\frac{1}{50}$th second. From the photographs the trajectory of the bead was made out. A very elaborate correction was made for the position of the centre of gravity of the bird, taking into account the differences of the position of this point, due to the up and down motion of the wings. From these data the true trajectory of the centre of gravity of the bird was calculated. Fig. 15 shows this line for a part of Example I in Mons. Marey's book; the gull was at the time flying slowly, viz., at the rate of about 15 miles per hour.

The method of calculating the forces exerted by the bird during each interval of $\frac{1}{50}$th second, is best shown in Fig. 16.

Let a, b, c, be the trajectory of the centre of gravity of the bird, a, b, and c being the positions occupied by the bird at the 0·18-inch, 0·20-inch, and 0·22-inch respectively. Let ade be a horizontal line; then ad represents the horizontal space passed over between the 0·18-inch and the 0·20-inch, de the similar space between the 0·20-inch and the 0·22-inch, and so on. Similarly, bd and ce represent the vertical rise (or fall). Now, since $\frac{1}{50}$-inch is a very short period, we may take

$$\text{force} = \text{acceleration per } \tfrac{1}{50}'' \times \text{mass of the bird};$$

consequently, if we know the trajectory, the forces can be calculated. As an example, let $ad = 103$ mm., $de = 119$ mm.; then

$$\text{acceleration per } \tfrac{1}{50}'' = 16 \text{ mm.}$$

$$\text{acceleration} = 0{\cdot}8 \text{ m. per second},$$

$$\therefore \text{ acceleration per } \tfrac{1}{50} \text{ in metres} = 40,$$

$$\text{and force} = 40 \times 0{\cdot}0637, \text{ when mass} = 0{\cdot}0637$$

$$= 2{\cdot}548.$$

The vertical forces can be found in a similar manner.

The estimation of the horse power, &c., has been very neatly worked out by Captain de Labouret from the forces, as calculated above, but, as the details are rather long, I must refer you to Mons. Marey's book for them. The general result, however, is—

$$\text{1st example, } \frac{7{\cdot}046}{75} = 0{\cdot}094 \text{ F.H.P.}$$

$$\text{2nd example, } \frac{7{\cdot}495}{75} = 0{\cdot}1 \text{ F.H.P. nearly,}$$

as the H.P. required to move the bird at the speed of about 15 miles an hour. For full flight Mons. Marey considers that about one-fifth of the above would be necessary

$$= 0{\cdot}02 \text{ F.H.P.}$$

Mr. Chanute's Method.

In the "Railroad and Engineering Journal" for February (and previous numbers), 1891, are some interesting articles on "Progress in Flying Machines," by Mr. Chanute. This gentleman considers a bird as an aeroplane, and calculates the power expended in the manner explained above for an aeroplane, making allowance for the concavity of the wings, &c. The two pigeons experimented on by him were of the following dimensions: largest cross section of body, 4·9 square inches and 5·3 square inches; largest cross section of edge of wings 5·02 and 4·88 square inches; weight of birds 1 lb. and 0·969 lb.; total surface of spread wings, projected body, and spread tail, 132·56 square inches and 151·04 square inches.

Corrections have to be applied to all the above.

Cross Section of the Body.—As explained for balloons, the resistance of a fair-shaped body may be taken as $\frac{1}{20}$ of that of its cross section; consequently the area for body resistance may be considered = 0·05 square foot.

Area of the Wings.—This is about 1 square foot, and allowing for concavity, may be taken as 1·3 square foot.

Resistance of the Edge of the Wings.—This is equal to the area × 0·15 as a reasonable coefficient.

Now to find the power required at various speeds; find by the usual aeroplane formula an angle which gives a lifting power approximately equal to the weight of the bird. The following examples show the power required at different speeds.

Speed, 20 miles per hour.
Normal resistance = 2 lbs.

Lifting power at 12° = 1·3 × 2 × 0·39 = 1·014 lbs.

Horizontal resistance at 12°	= 1·3 × 2 × 0·0828	= 378·7	ft.-lbs.
Body resistance	= 0·03472 × 2 × 0·05 =	6·1	,,
Edge of wings	= 0·03472 × 2 × 0·15 =	18·3	,,
		403·1	,,

∴ H.P. required = 0·0122 H.P.

For other speeds—

5° and 30 miles per hour	.....	317·2	ft.-lbs.
3° and 40	,, ...	394·2	,,
2° and 50	,, ...	556·5	,,
1½° and 60	,, ...	827·3	,,

The reason why more power is required at 40 miles an hour than at 30 miles per hour is that the body resistance increases as the square of the velocity. This body resistance is a very important element in the case of a bird or small object, and has to be taken into consideration, especially in large flying machines.

According to Mr. Chanute, a bird usually carries its plane at an angle of about 3°, and this is the angle where the resistance is about a minimum. He has added to the table of bird dimensions, &c., in Mons. Mouillard's "L'Empire de l'Air," a column showing the speed which each bird would fly at, supposing the angle of its plane to be 3°. The following are a few examples:—

Bat.....	15·9	miles per hour.
Swallow	23·1	,,
Kingfisher.....	30·3	,,
Rook	33.3	,,
Quail	42·3	,,
Gray pelican	51·3	,,
Male duck	66·2	,,

Mons. Richet's Views.

Mons. Richet, the editor of the "Revue Scientifique," endeavours to find the work done by a bird by the use of chemical formulæ, and the investigation is interesting as being an entirely different method of approaching the subject. It is based upon the following principles: a bird when in repose produces a certain amount of carbonic acid gas per kilogram of its weight per hour. Now if we can ascertain the amount produced when the bird is in motion, the difference will give us a basis from which to calculate the work done in flight.

Mons. Richet considers, from his own experiments and from those of other experimentalists, that a pigeon weighing 320 grams will produce 3·3 grams of carbonic acid gas per kilogram of its weight per hour, when in repose. Now we have no means of ascertaining exactly the amount that the bird will produce when in motion, but it seems probable that the increase will bear a similar ratio to that found by experiment to be the one for men and animals. This when a fair amount of exertion is being put out is about three times the amount when in repose. Assuming this to be correct, the bird would give out $3 \times 3{\cdot}3$ grams, say 10 grams per kilogram of its weight per hour when in full flight. Now deduct the amount given when in repose, and 6·6 grams is left as a basis for further calculations. By chemical experiment it has been found that 1 gram of carbonic acid gas is equivalent to 2·575 calories; consequently the 6·6 grams are equivalent to 17 calories. Now since the ratio of chemical to mechanical work is about 4 to 1, we may consider the mechanical work done as

$$= 4 \text{ calories} = 4 \times 423{\cdot}985 \text{ kilos.}$$

$$= 1{,}700 \text{ kilos. per hour.}$$

$$= \tfrac{1}{2} \text{ kilo. per second per kilo. of weight.}$$

This formula, if applied to the gull experimented on by Mons. Marey, would give about twice as much power required for full flight, but Mons. Richet states that $\frac{1}{2}$ kilogram is probably too high.

In concluding this part of the subject I may mention that Mons.

Tatin, in his paper in the "Revue Scientifique," makes the power very much lower, viz., about 0·0025 F.H.P. as a minimum and 0·0150 F.H.P. as a maximum.

Possibilities of Flight in Man.

For centuries it has been the ambition of man to fly in the air with the speed of a bird, and the number of flying machines which have been invented is almost countless. I do not believe that it is possible for a man to fly by means of wings, without some assisting power. For suppose a large bird-shaped machine to be built, having a wing-surface of 200 square feet, inclination of plane 2°. Now using the aeroplane formula, and considering the weight of the man to be 150 lbs., then for a speed of v miles per hour the

$$\text{lifting power} = 200 \times \frac{v^2}{200} \times 0{\cdot}07,$$

$$= 150 \text{ lbs.};$$

$$\therefore v = 46 \text{ miles per hour};$$

and the resistance would be

$$200 \times \frac{46^2}{200} \times 0{\cdot}0025 = 5{\cdot}3 \text{ lbs.},$$

$$\text{giving a H.P.} = 0{\cdot}65 \text{ E.H.P.}$$

Now in the above calculations no allowance has been made for the weight of the machine, or the body resistance of the man. Both of these would very largely increase the power required, and, as a man can only conveniently exert $\frac{1}{10}$th H.P., it seems pretty certain that some extra power will be required to move him through the air.

Successful Flying Machines.

Up to the present (with the exception of Mons. Ader's machine) no full-sized apparatus has flown in the air. A good number of flying models have been constructed, such as the butterfly toy, de Pichancurt's bird, &c. One very good example is Mr. Hargraves' model shown in Fig. 17. The motor is compressed air, stored in the tube which forms the backbone of the apparatus. This tube is 2 inches in diameter and 48¼ inches long; its weight being 19½ ounces. The air pressure is 230 lbs. to the square inch. The engine weighs 6⅓ ounces, its cylinder being 1½ inches in diameter; stroke 1¼ inch. The piston rod is fastened to the tube, the cylinder working up and down, moving the wings. The wings are of paper and weigh 3 ozs.; their area is 216 square inches, and that of the body is 2,128 square inches. This model flew 368 feet on a calm day.

Ader's Flying Machine.

Fig. 18 shows Mons. Ader's flying machine. He is reported to have risen 60 feet in the air, and taken short flights of some 300 yards or 400 yards; but all details of the machinery are kept a secret. The real moving power is the screw in front, though I believe the wings are used to assist in rising from the ground.

Maxim's Flying Machine.

Constant mention is made in the public press of Mr. Maxim's flying machine. In the "Century Magazine" for October, 1891, he has written an article entitled "Aerial Navigation," the power required, describing the results of some of his experiments, and giving some information about the machine. It appears to be an aeroplane, with a car attached underneath; the supporting surface being about 5,500 square feet, and the angle of inclination 1 in 14, or 5° 43′. It is not quite clear from the article whether the angle can be varied, but presumably it can. The weight of the machine, engines, passengers, fuel, &c., is 5,000 lbs., and as he can carry 14,000 lbs., there is some 9,000 lbs. of weight to spare. The engines are extraordinarily light, weighing only about 13 lbs., and perhaps less, to the H.P. The push of the two screws is 1,000 lbs. when 120 H.P. is used; this would, with a 5° 43′ inclination, give a speed of about 45 miles per hour for motion on a level. The steam generator is self-regulating, has 48,000 brazen joints, and is heated by 45,000 gas jets, the gas being made from petroleum. Mr. Maxim is very sanguine as to its success. One doubtful point has been noticed by Mr. Brearey, in the "Proceedings of the Aeronautical Society," viz., that we do not at present know whether the rules for aeroplanes moving on a whirling table are strictly applicable to aeroplanes moving freely through the air. This is, of course, a very important point, but it can only be settled by making the experiment.

Motors and Methods of Propulsion.

The great difficulty, both in "Ballooning" and "Aviation" is to get a sufficiently light motor. At present, owing to the fact that such articles are not much in demand, 40 lbs. per H.P., is looked upon as a small weight; but there does not appear to be any reason why this should not be very largely reduced. Mr. Stringfellow's engine (1868) weighed only 13 lbs. per H.P., and an engine lately invented by the Rev. T. Jones comes to only about 14 lbs. per H.P. A description of this latter engine is given in General Hutchinson's "Navigable Balloons in War and Peace." Mr. Maxim's engine is probably a good deal lighter than either of the above, and, I believe, that when the matter is thoroughly gone into, it will be found possible to very largely reduce the present weights. I may add that as far as can be seen at present, a steam engine appears to be a more promising motor than an electrical one.

Next, as regards methods of propulsion, I do not think that any form of wing action is desirable, as the machinery for this kind of motion must be complicated, and will require very nice adjustment. At present a fine-pitched screw propeller, revolving at a rapid rate, appears to be the best, but probably in the future some form of jet propulsion will come into general use, as we cannot allow the enormous power given out by the explosion of gun-cotton or powder to be wasted for ever.

The Method of Calculating the Power Speed of Machines of the Aeroplane Type.

We have now to examine the general method of calculating the power, speed, &c., of a machine of the aeroplane type, and this will be best shown by an example.

Conditions.

Aeroplane.—110 ft. × 50 ft. = 5,500 sq. ft. of surface; angle of inclination, variable at will.

Car.—About 70 ft. long, fair shaped, largest cross section, $7\frac{1}{2}$ ft. × 10 ft.

Weights.—Aeroplane, car, &c., about 5,000 lbs., engines, fuel, &c., about 10,000 lbs.; 300 G.H.P., or about 33 lbs. per G.H.P.

Propelling Machinery.—Two two-bladed screws.

Method of Starting.—Either by running along a line of rails and rising in the air when the air pressure lifts the machine, or by holding the machine firmly to the ground, and allowing it to rise when there is sufficient air pressure to maintain it. Proper arrival and departure stations would have to be built.

Method of Descending.—Speed of descent to be checked by auxiliary planes, and suitable horizontal velocities to be chosen from the calculated tables, which will allow of the rate of fall being not greater than 22 ft. per second.

Calculations.

The general theory of aeroplanes has already been gone into. The calculations now required may be conveniently arranged as follows:—

1. Lifting power, and rising and falling velocities.
2. Horizontal resistances and the powers required to overcome them.
3. Convenient speeds, &c., and the power required.
4. The trajectory of the machine in the air under given conditions.

Lifting Power, &c.

(1.) From the aeroplane formulæ:—

$$\text{Lifting power} = 5{,}500 \cos \alpha \times \frac{v^2}{200} \times \frac{2 \sin \alpha}{1 + \sin^2 \alpha}.$$

Hence by assuming any convenient angle, and substituting values of v, such as 10 miles per hour, 20 miles, 30 miles, and so on, a table can be drawn up, as shown below, giving the lifting power for any given speed.

2. Rising and falling velocities. As already explained, the aeroplane will rise when

$$\text{SR} \cos \alpha > \text{the total weight},$$

and it will fall when it is less. Let the rising or falling velocity $= v^1$, then

$$v' = \sqrt{\left(\frac{\text{lifting power} \pm 15{,}000}{\text{S}}\right)} 200 \text{ miles per hour.}$$

It should be noticed, when considering these rising and falling movements, that the pressures are practically speaking those on a horizontal plane; for, when the angle of inclination of the aeroplane is very small, R cos α = R = weight.

The table below gives the lifting power and the rising and falling velocities for an angle of inclination of 3°.

TABLE I.

Velocity in miles per hour.	Lifting power.	Downward velocity.	Upward velocity.
	lbs.	ft. per sec.	ft. per sec.
0	0	34·24	0
10	286	33·88	..
20	1,144	32·85	..
30	2,574	31·09	..
40	4,576	28·45	..
50	7,150	24·79	..
60	10,296	19·21	..
70	14,014	7·48	..
80	18,304	..	16·13
90	23,166	..	23·61
100	28,600	..	32·70
110	34,606	..	39·16

N.B.—When the machine has a horizontal velocity of 72·3 miles per hour, it will just move along in *the air* on a level.

Horizontal Resistances and G.H.P.

(1.) The horizontal resistances to be overcome are—

a. Air resistance to aeroplane.
b. Air resistance to body of car, ropes, &c.
c. Rail resistance while the machine is on the ground.

(*a.*) The air resistance to aeroplane is found

$$= 5{,}500 \sin \alpha \frac{v^2}{200} \times \frac{2 \sin \alpha}{1 + \sin^2 \alpha},$$

and can be tabulated in the same manner as the lift.

(*b.*) The body resistance may in this case be taken

$$= 75 \times \frac{1}{15} \times \frac{v^2}{200}.$$

(*c.*) Rail resistance. From Forney's "Catechism of the Locomotive" this is found to be—

Speeds.	Resistances per ton of 2,000 lbs.
10	6·6 lbs.
20	8·3 „
30	11·2 „
40	15·3 „
50	20·6 „
60	27·0 „
70	34·6 „

The following table shows all these resistances for the various speeds:—

TABLE II.

Velocity in miles per hour.	Resistance in lbs.					Gross horse power required to drive the machine through *the air.*
	Air.	Body.	Rail.	Total.		
				Without rail.	With rail.	
0	0	0	0	0	0	0
10	14·85	2·5	49·70	17·35	67·05	0·60
20	59·40	10	62·25	69·40	131·65	4·69
30	133·65	22·5	84·00	156·15	240·15	14·98
40	237·60	40	114·75	277·60	392·35	42·27
50	371·25	62	154·50	433·25	587·75	64·71
60	534·60	90	202·50	624·60	827·10	108·96
70	727·65	122	259·50	849·65	1,109·15	171·33
80	950·40	160	..	1,110·40	..	253·52
90	1,202·85	202	..	1,404·85	..	357·46
100	1,485·00	250	..	1,735·00	..	485·91
110	1,796·85	302	..	2,098·85	..	640·42

N.B.—The gross horse power required to drive the machine on a level through the air at 72·3 miles per hour = 189·75 G.H.P.

(2.) The G.H.P. required to overcome the resistances is—

$$= \frac{\text{Resistance in lbs.} \times \text{speed in ft. per minute}}{33{,}000}.$$

To find the G.H.P., a percentage must be added for slip of the screw; the amount of this is not well known, but I have taken it as follows:—

Speed in miles per hour.	Percentage of slip.
10	30
20	24
30	20
40	16
50	12
60	9
70	8
80	7
90	6
100	5
110	4

Table II, above, shows the above calculated resistances and G.H.P.

Speed, Power, &c.

An inspection of the above tables for 3° inclination shows—

1. That the machine will move on a level in the air at a speed of 72·3 miles per hour.

2. That the G.H.P. required to so move it is 189·75 G.H.P.

3. That a convenient rising velocity is about 16·13 feet per second, and that this would be attained when the machine had a horizontal velocity of 80 miles per hour.

4. That a convenient descending velocity, leaving out of consideration auxiliary aeroplanes, would be 7·48 feet per second, which is attained when the horizontal velocity is 70 miles per hour. It must be understood that these results only apply to a 3° inclination; a lower inclination of the aeroplane would, of course, be much more favourable to rapid motion.

Trajectory of the Machine in the Air under given Conditions.

From the above tables we can work out the trajectory of the machine (see Fig. 19). Starting from A at 9 A.M. with a velocity of 80 miles per hour, in one minute the machine would be at B, 967·8 feet above the ground. C would be reached at 10 hours 1 minute, 72·3 miles having been covered in one hour. In coming down (leaving out of consideration the use of auxiliary planes), the falling velocity might be 7·48 feet per second, and the ground would be reached at 10 hours 3 minutes 9·4 seconds.

The above calculations are, of course, very general, simply to give you an idea of the method employed.

General Remarks on Aviation.

Apart from the military value of such machines, from the mechanical point of view, the advantages and disadvantages of this class of apparatus appear to be:—

Advantages.

1. Very high speeds, with small expenditure of force.

Disadvantages.

1. As regards any wing-motion machines, the difficulty of producing the wing motion satisfactorily.
2. Owing to the high speeds and enormous differences of pressure caused by very slight alterations in the inclination of the aeroplane, great skill and watchfulness will be required on the part of those responsible for the working of the apparatus.
3. The difficulty of getting a sufficiently light motor. This affects any form of flying machine more than it does a balloon, as a flying machine is entirely dependent on a high speed, to supply the lifting force.
4. The danger in coming down with a high horizontal velocity. This can, I think, be arranged for by using auxiliary planes, and thus increasing the lifting power. It will not then be necessary to maintain a high horizontal velocity, in order to get a convenient vertical speed.
5. The difficulty of keeping the aeroplane at any particular angle. Until a trial has been made, it is hard to say whether this difficulty really exists or not.

Concluding Remarks.

In concluding, I wish to specially bring to notice the following points:—

1. The very great importance of "aerial navigation" to this country. The success of aerial machines will enormously affect the position of the United Kingdom; in fact, there is no country in the world which will be so much affected. A total change will have to be made in our defensive system; the value of our Navy will be very much reduced, and the "silver streak," of which we hear so constantly, will, for all practical purposes, disappear. An aerial navy of the very first class will be an absolute necessity, if we are to maintain our position as one of the leading Powers in the world.
2. The importance of making really careful and scientific experiments on the subject, so as to obtain thoroughly satisfactory data to work from.

Hitherto, the most absurd mistakes have been made about air-pres-

sure, &c., simply because proper experiments were not carried out. For instance, it has for years been supposed that if a plane were projected horizontally with any velocity, however high, it would always reach the ground in the same time that it would do if it were let fall without any horizontal velocity at all. Professor Langley's experiments show that this is not the case, and that the time of fall is very largely increased by giving a high horizontal velocity.

I mention this case, because such a very simple matter as this, one of enormous importance to aerial navigation, has apparently only been discovered in 1891!

In conclusion, I will quote a remark said to have been made by Mr. Maxim, who is now constructing a flying machine of the aeroplane type:—

"If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitro-glycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die, someone will come after me, who will be successful if I fail. . . . It can be done as sure as fate. I have spent 45,000 dollars already upon it, and I did not enter upon the work until I was convinced that the idea was practical."

List of Books, Papers, &c.

"Proceedings of the Institute of Civil Engineers," vols. lxvii and lxxxi.
"Navigable Balloons in War and Peace," by General Hutchinson.
"Aerial Navigation," 1891, Chanute.
"Railroad and Engineering Journal," 1891, 1892, "Progress in Flying Machines," by Chanute.
"Le Vol des Oiseaux," by M. Marey.
"L'Aéronaute."
"Revue de l'Aéronautique."
"Scientific American," and Supplement.
"La Navigation Aérienne," by Tissaudier.
"L'Histoire des Ballons," by Tissaudier.
"The "Century Magazine," 1891.
"Experiments in Aerodynamics," by Langley.
"Fores' Sporting Magazine," 1890, 1891.
"L'Empire de l'Air."
"Revue Scientifique," &c., &c.
"Proceedings of the Aeronautical Society of Great Britain."

Mr. George Phillips, R.E.: With your kind approval I should like to make some remarks upon this most important subject of Aerial Navigation. I agree with the lecturer that in this country aeronauts, or, more properly speaking, people who profess to have discovered *the* way of navigating the air, are looked upon as a species of harmless lunatic. The reason that this is the case will be apparent when I explain that with a few notable exceptions all these people are only theorists, and in this more than in any other science there seems to be no limit to the wild schemes proposed by them. To give instances of the humbler inventors, I may mention that one ingenious gentleman, arguing that air does not give much hold to

a screw, proposed that a small tank containing water should be suspended under the balloon, and the screw made to revolve in it. Another ingenious inventor at the Aeronautical Congress in Paris proposed a system of propulsion, in which a long lever with a weight at the end was raised by clockwork; when it arrived at the horizontal position it was suddenly released and fell vertically. He hoped that the successive jerks thus given would propel a balloon. More discredit, however, is brought on the subject by those who have scientific theoretical knowledge, without having the least idea of the practical difficulties which render their schemes unworkable. The lecturer would appear to have drawn too much on books and newspaper articles for the subject of this important lecture; and I am sorry to see that good, bad, and indifferent inventors have been placed side by side in such a way that it may lead to quite an erroneous impression as to the feasibility of aerial navigation. It is not right as it seems to me to compare true scientists like Giffard, Dupuy de Lôme, the brothers Tissaudier, Renard, and Krebs, with the schemes of Campbell and Mayer. The lecturer's own scheme for a navigable balloon with his curves formed by a trochoid of revolution is open to the practical difficulty that the extremities from their shape would be extremely difficult if not quite impossible to keep rigid. The means at our disposal for this are the interior air balloon as employed in France, and also the bar compressor of General Hutchinson, which latter, as far as I know, has never been practically tried. Easy entrance curves are not required for balloons or machines working in air, for air is a fluid having elasticity which water has not, and the resistance to forward motion is greatly dependent upon dealing effectually with skin friction. It may be interesting to note that a scientific Commission assembled by the French Government in 1888 to report upon the capabilities of navigable balloons arrived at the conclusion that, owing to the difficulty of keeping the envelope taut, and also on account of skin friction, navigable balloons could not be made to go at a speed exceeding 30 miles an hour. A steam engine has been proposed by the lecturer as being the best means of propelling balloons. The experiments carried out in France by those who are the greatest authorities on the subject, the Chalais-Meudon people, show that in the first instance they tried an electric motor (with which the experiments with "La France" were carried out), worked by primary batteries.[1] They then tried a petroleum motor which they shortly had to abandon. This has now been succeeded by another electric motor, but whether it is worked by primary or secondary batteries, I do not know; but the result obtained has been that 10 kilos. is the total weight per H.P., which allows of working for ten consecutive hours. The reason why a steam engine will not do, is the fact that the condensation of the water presents practical difficulties which are almost insurmountable. In 1887 Mr. Yon, the eminent aeronautical engineer in Paris, was entrusted by the Russian Government with the construction of a navigable balloon. This balloon, 66 metres in length, was to be driven by a petroleum engine of 50 H.P., and it was estimated that it would obtain a speed of 25 miles per hour. Everything went well except the condenser, and after trying every possible device, they failed to get it to work. Without a condenser, they lost 750 lbs. per hour simply through their water, which destroyed in great measure the equilibrium of the balloon.[2] Of course I have not lost sight of Mr. Maxim's steam generator, which appears to be a very light and good motor, but then Mr. Maxim has to allow for fuel about 9 lbs. per H.P. per hour; which for ten hours makes 90 lbs. weight of fuel, and this does not compare favourably with the French electric motor. Respecting the experiments which have been carried out with machines heavier than air, there is no doubt that Mr. Hargraves, Mr. Maxim, and Professor Langley have carried out experiments which will prove of great value to us; but strange machines, like those of M. Ader, we only know of by newspaper reports, and we have no proof that they ever did go up. All

[1] These batteries, five to six times more powerful than bichromate batteries, have as poles platinized silver and zinc; the liquid consists of equal parts of hydrochloric acid and chromic acid.

[2] After this failure with the condenser, the Russian Government claimed the balloon as it was and took it to Russia. What they have since done with it is unknown.

we require for aerial navigation is a light and powerful motor; that the French apparently have got, and if we could have it, there is no doubt that a reasonable sized navigable balloon could be made which would go up to 30 miles an hour. The great objection against navigable balloons has been their cumbersomeness. The machine of the future undoubtedly will be some form of a machine heavier than air. Experiments are being made, but whether they will succeed or not, we do not know. I hope Mr. Maxim will be successful, but there is no doubt he will have practical difficulties in the descent which may be excessively dangerous. A successful aerial machine heavier than air will require to be able to take its own weight from rest, and to come down vertically and gently.

Mr. J. STRINGFELLOW: I have very little to add to what Captain Fullerton has said, because he has treated this subject in a most masterly way. There are one or two minor points necessary to add to what is stated. One being that, between the latter end of the last century and the commencement of the present one, there were great efforts made towards aerial navigation. Of course, they had not the advantage of coal-gas; they had to work with hydrogen; but if we were to take the diagrams before us and to compare them with the diagrams of designs drawn out up to the year 1820, we should then find the whole of them already set out, and the mathematical calculations and researches made, connected with them. However, neither in what has formerly been designed or proposed, nor in any of the designs and proposals submitted to us by the lecturer, is there contained the essential requirements for practical aerial navigation. I believe there is no one who has gone into this matter so deeply as I have, and, as an engineer and a practical man, I claim to have solved the question of aerial locomotion. I am not prepared to say anything about it publicly, because I am waiting the opportunity to demonstrate to the world that an Englishman can master practical aerial locomotion the same as we have mastered land and water locomotion. I may say that having worked the whole of it through as to its principles, and without reference to any text-books, I find the principles underlying flight are the simplest mechanical laws that it is possible to conceive. Wing-power is the simplest form of non-resisting propeller for a given expenditure of energy. With regard to the wing-motion, the power derived from it is not so much the blow on the air, or the force exerted for lifting purposes, as it is that of a sinuous cleavage power. The fish in the water and the snake in the grass move by a similar law. Mr. Hiram Maxim, one of our best mechanical engineers, seeks to obtain combined levitation (that is, rising from the ground) and propulsion by a machine, or by mechanical force alone. It is self-evident that we cannot trust to such a means as that for practical aerial navigation, although of course it is perfectly practicable to so obtain rising and propelling power. But if we should adopt such a machine as could rise in the air, it being simply a machine, if any part of the mechanism went wrong, or the motive power were to stop, all control would be lost, and it must come down crash; the same as a bird will if it is winged or loses its power of motion. It is imperative to have supporting or buoyant power as well as mechanical flight or propulsion. The simplest form of mechanical propeller is the wing, but the great difficulty in the adaptation of wings to aerial navigation has been the enormous leverage supposed to be required. For example, presuming a practical machine or aerial vessel was constructed, it would have to be something like 160 to 200 feet long; the wings for that dimension necessarily being an enormous length would require an enormous leverage to work them; but, in following it through, I found there was an easy way to get over that, and yet to retain practical efficiency. The other thing was with regard to guiding power. Amongst the 100 or so designs exhibited at the Aerial Exhibition held at the Alexandra Palace a few years ago, there was not one system or design that indicated the true method of guidance, that is, the method by which birds guide their flight. It took me six years to find out how the birds flew—that is the correct principles of bird flight, and it took me four years more to find out how they guided themselves. For aerial navigation there is required: 1st, displacement; 2nd, motive power; and 3rd, guidance; and we have to assimilate these and bird flight to mechanical principles for a practical result. I built a machine entirely on those principles, an elongated balloon-shaped body for displacement, and worked it both with and without gas, and which, in motion and guidance, answered perfectly.

The CHAIRMAN: We would rather have a discussion on the paper than a vague account of what has been done in other places.

Mr. STRINGFELLOW: I will conclude by intimating that I shall be happy to place myself at the disposal of any of the Royal Engineers, to go into the matter with them privately.[1]

Mr. BADEN-POWELL (Scots Guards): I perhaps might be allowed to say a word or two on the lecture, which has been very interesting and very exhaustive. There is nothing very much to add, but I should like to make one or two suggestions. First, I see a picture of the screw of "La France." This screw is placed in front, and I understand that this was an ordinary shaped screw to draw the balloon, or rather the car, along. The lecturer has not referred to another balloon which was designed and, I believe, built and actually tried by a gentleman named Gower, who lectured in this Institution some years ago.[2] He placed a "flat screw" (if such a term can be applicable) in front of the horizontal axis of the balloon itself. This screw worked in such a way as to drive away air and so form a vacuum in front of the envelope, and so, as it were, suck the balloon along. This seems to me rather a good idea theoretically, because there is always a difficulty about the stiffness of a balloon, and if a vacuum is created just in front of it this stiffness is not then so necessary. I should also suggest that a framework inside the balloon seems a necessary thing. In propelling a gas bag along through the air it is always liable to be more or less flabby unless it is in some way pressed outwards. I should suggest a framework somewhat similar to that of an umbrella, which, I think, could be made very light. It is merely a matter of calculating what weight it would have to be; but some such light framework would keep the balloon stiff, and then it could be propelled with much greater ease than is the case with a flabby bag. Theorists very often assume that a balloon is an air-tight bag blown out quite tight, but I know in practice that this is by no means the case. There is always a certain amount of leakage, and temperature affects the gas so much that you would nearly always find that if the balloon was quite tight to start with a certain amount of gas would soon escape or contract from the coldness of the air, and this, it seems to me, would necessitate some stiffening. Of course, if the balloon had a framework inside it, it would have to have something like a small balloon inside connected with the outer air so as to allow for expansion and contraction. Temperature affects the lifting power of a balloon so greatly that I think it an absolute necessity to have some mode of making a balloon rise and fall without wasting gas or having to carry heavy ballast. I could give a practical instance. I remember being in a balloon when we were up at a height of 3,000 or 4,000 feet in sunshine. A cloud came over the sun, and the balloon, owing to the contraction of the gas, went straight down and landed us on the ground, and did not seem inclined to go up again, so without letting out any gas, a balloon can fall in that way, and have no lifting power when on the ground. That just shows how, in practice, you discover facts which you would hardly think were applicable in theory. Then, again, the lecturer divided the subject into two distinct portions: one as to navigating a vessel lighter than the air; and the second part dealing with apparatus heavier than the air. I do not see myself why these two should not be to some extent combined (as has been suggested several times before). Having an apparatus made, we will say, like an aeroplane, as generally designed, but having two skins: the interior might be blown out with gas, and in that way you might have a sort of flat-shaped balloon which would have a certain amount of lifting power, and in this way the apparatus may be greatly lightened. I do not say I should look upon that as really a practical apparatus for the future navigation of the air, but it seems to me something might be done in that way with an experimental machine. Of course, the subject is a very difficult one to deal with, because inventors are jealous, and foreign nations, who are designing these balloons for military purposes, naturally keep their inventions very secret, so that the only accounts we get of all these are

[1] Mr. S. wishes it to be noted that he addressed himself more to the abstract question of accomplishing successful aerial navigation than to criticizing the paper read by Captain Fullerton.

[2] See Journal, No. 131, vol. xxix, 1885.

from the newspapers, and we know how often newspaper accounts are very inaccurate and misleading. It seems a pity in some way we cannot get at greater details, but, of course, we cannot expect it. If countries are at work in rivalry you cannot expect them to tell each other what they are doing. With regard to an aeroplane, what we want is to start the machine at a very rapid pace, and once it is going along in the air I should have thought it would not have required that speed to be kept up by mechanical propulsion. If we look at an albatross soaring in the air we know it somehow starts—we won't go into how it starts, because very few people have seen one start; but once well under way it has a certain amount of speed on it, and it goes along somehow managing to sustain itself in the air. If we have a machine which could be started by some very powerful engine, such, for instance, as compressed air, or some explosive so as to start it at a great rate, then I expect we should require a very much less amount of engine to merely propel it gently along after once it has got the start. However, it is, of course, very difficult to say how such theories will work in practice. It is a matter for more experiment, and I only hope we shall get more experiment.

Captain S. GORDON MCDAKIN: After so much has been said, and very much to the purpose, on the subject of flight, I trust you will excuse the very few observations I shall attempt to make upon the subject. It does not appear to me (although perhaps my powers of apprehension may not have been sufficient to understand) how far the lecturer has intended to represent a flight of birds dealing with a succession of columns of air. In Diagram 15, where you may take the columns of figures as representing successive columns of air and flight of birds passing along, I think we could understand how when they came in succession over each column of air they would have to overcome the inertia of that column; whereas any screw device acting in a stationary manner pulls down the column of air, so that it is always grinding or churning, as it were, one column instead of passing in succession from column to column, and overcoming in succession the inertia of these several columns of air. It seems to me to be very much like the difference between grains of sand falling upon a lecture table and grains of sand passing through a tube 10 to 30 feet in length, when the effect is very different. The whole column of air above it is set in motion: the grains of sand coming down would, under these circumstances, perforate a slab of glass an inch in thickness, and even a slab of granite the same thickness. I do not think this principle has been recognized in dealing with flight, as it might have been by many who have touched upon the subject. The great difference between screw action and the action of wings of birds in flight is, that in flight the bird is encountering a succession of columns, and having to overcome their inertia glides along them, instead of simply acting in one place, as does a screw propulsion.

The CHAIRMAN (General Dawson-Scott): I feel myself rather an impostor in sitting in the chair on this occasion, because I have devoted no great attention to flying machines, or to dirigible balloons; but I happen to be Commandant of the School of Military Engineering, and in that position I am Captain Fullerton's Commanding Officer, so when he asked me to take the chair I felt great pleasure in doing so, more especially because his lecture is on a subject of great interest. We hear of German balloons on the Russian frontier sailing about, and apparently being under perfect control, and I suppose what the Germans can do we ought to be able to do. I have seen a good deal of military ballooning, and one of the gentlemen who has spoken upon the present occasion has been employed under me, and I know him to be a very good practical balloonist, as also we know Mr. Baden-Powell to be. They know the difficulties that have to be encountered, and have pointed some of them out. The diagrams before us seem very complicated. They show what has been done, and indicate what very large balloons or flying machines we must expect to have to deal with for either aviation or ballooning on a large scale. I am sorry the lecturer did not give Fig. 8 the same scale as Fig. 6. The latter, he told us, was 40 feet long, a balloon propelled through the air, and not an entire success, by one man. Fig. 8, which was proposed to be the war balloon of the future, is 240 feet long and 30 feet in diameter. That would be a troublesome thing either to make or to guide, or to manage in any way. I will allow the lecturer to contradict me afterwards, but I rather think that we are mistaken in

supposing that the war balloon of the future must of necessity be such a big machine. I do not think Mr. Maxim, who has been referred to as making some flying machines at the present time, and who we all know to be a very ingenious man, contemplates having such a large balloon, capable of carrying great weight, as is there portrayed. In fact, a gentleman remarked to me to-day that in some paper that Mr. Maxim had written at the end of last year he said he thought the war balloon of the future would be simply used, as the captive balloon is now, as a means of observation, in which case it would only have to take up one or two men to reconnoitre the enemy's troops and forces, and I think that the idea of dropping half a ton of dynamite on to an enemy's ship, or into an enemy's town, though it looks very formidable here, is rather outside of practical politics as far as we have got at present. I think the lecturer himself does not quite believe in it. I feel sure that if any of us really thought that any action of ours could upset our naval defensive system, or make the "silver streak" for practical purposes disappear, we should refuse to have anything to do with it. With these few remarks I will ask the lecturer to reply to the observations that have been made.

Captain FULLERTON: I have not much to say in reply. With regard to the shape of the proposed war balloon, it is difficult to show it properly; there should be more of a dip here, and it should be more of the shape called by naval architects "fair shaped." I think this form gives the least resistance to forward motion, a very important matter. The size of the balloon of course depends upon how much weight you want to take up. For reconnoitring balloons, perhaps two or three men are as many as are wanted, but you can hardly take less. Our spherical balloons, without any engines or machinery, require a 10,000 cubic feet capacity for three men, and of course if you have machinery, &c., the lifting capacity must be increased. The reason why I choose Myers' aerial bicycle is, that this is a class of machine which can be easily made anywhere. It could not go very fast, but some 9 miles an hour might be got out of it without much difficulty. As regards the feasibility of dropping or firing shells downwards from a balloon, there does not seem to be much difficulty in the matter. No doubt it would be very pleasant for us if arrangements of this sort were not likely to be invented; but if other people are going to invent them, and use them against us (as they specially say they will), surely the best plan is to try and get ready to defeat their efforts.

The CHAIRMAN: It only remains for me to ask you to join me in giving a vote of thanks to Captain Fullerton for his lecture.

NOTES.

1. *Chalais-Meudon Experiments.*—The Chalais-Meudon people do not seem to have touched the subject of aeroplanes. The experiments of Professor Langley were most carefully carried out, the newest and best forms of recording instruments having been used, and they most certainly cannot be considered to be of "secondary importance," as Mr. Phillips suggests. I may point out here that in a comparatively new science like "aerial navigation" it is of the very greatest importance to look at the subject from different points of view, and, in doing this, books and newspapers are of the very greatest assistance.

2. *Shape of Balloon Bodies.*—I do not agree with the idea that "easy entrance curves are not required for machines working in the air." A "fair shape" is essential. It is impossible to drive any but "fair shaped" bodies through the air *at a high rate of speed.* As regards skin friction I agree with Mr. Maxim, who expressly states in his published account, as a result of his experiments, that there is very little or no skin friction. Mr. Langley's experiments apparently give the same result.

3. *Motors.*—Eventually an electric motor may be found to be the best, but Commandant Renaud stated, in "L'Aéronautique" (1889), that electricity was a failure, and would not be used in future. As regards steam, see note on Condensers.

4. *Condensers.*—I am not aware how the Chalais-Meudon people tried their condensers; but one would imagine that condensers moving through the air would

work rather better than those stationary on the ground. If the air is allowed to play freely upon the tubes, or surfaces, the condensing power must be largely increased. Most probably, in the case quoted by Mr. Phillips, this was not done.

Mr. Maxim puts his condenser in the aeroplane, and he states that it is very efficient.

5. *Coal and Water.*—9 lbs. per I.H.P. per hour is the usual amount allowed for the ordinary class of engine. Nobody, however, supposes that Mr. Maxim's is an ordinary engine. His own published statement shows about 1,000 lbs. of coal and water allowed for (I understand) a ten hour trip. If 9 lbs., as above, was allowed, the coal and water alone would weigh some 27,000 lbs., or nearly twice as much as the total weight of his machine, engines, baggage, &c.!!!

6. *Temperature as affecting Balloons.*—Of course there is always a certain amount of flabbiness about a balloon, but the ordinary rules of physics explain how the temperature affects the gas in it. I should imagine the case quoted by Mr. Baden-Powell was due to the fact that, owing to the sunshine, the gas expanded and some had to be let out of the balloon to prevent it straining the envelope. When the clouds came out the gas contracted, and there was not sufficient left at the lower temperature to keep the weight up in the air.

7. *Gower's Balloon.*—I cannot explain the principle used by Gower. It depends entirely upon the theory of the screw propeller; but at present this theory is more or less in the clouds. I think the general tendency of a screw worked in this manner would be to cause a great strain on the balloon

8. *Combination of Ballooning and Aviation.*—There is, of course, no reason why the two systems should not be combined. I divided the subject simply because I think it is easier to understand it when its branches are considered separately.

9. *Flight of Birds.*—Fig. 15 is not intended to show a "flight" of birds, but the different positions of the gull's wings at intervals of $\frac{1}{20}$ sec.

10. *Use in War.*—Mr. Maxim says: "When the first flying machine succeeds, its first great use will be for military purposes. . . . . It will at once become an engine of war, not only to reconnoitre the enemy's positions, as has been attempted with the so-called dirigible balloons, but also for carrying and dropping into the enemy's lines and country large bombs charged with high explosives."

J. D. F.

Wednesday, May 18, 1892.

ADMIRAL SIR R. VESEY HAMILTON, K.C.B., Member of Council, in the Chair.

DISCUSSION ON THE SUBJECT OF THE NAVAL PRIZE ESSAYS, VIZ. :—

"Maritime supremacy being essential for the general protection of the British Empire and its commerce, to what extent, if any, should our Naval Force be supplemented by fixed defences at home and abroad, and to whom should they be confided?"

POINTS FOR DISCUSSION.

PRIZE ESSAY. (See Journal, p. 410.)

Author's General Conclusions.

1. That to the Navy should be entrusted the duty of sweeping the high seas and of keeping them clear of the enemy's cruisers.
2. That, after our maritime supremacy has been assured by building a sufficient number of ships, our naval force should be supplemented by certain fixed defences, raised to meet a definite purpose at our different ports at home and abroad; this purpose being to resist a raid or attack by one or more cruisers for a few days, and to offer a safe refuge for our war-ships and mercantile marine while coaling, loading or unloading, or under repair.
3. That these fixed defences are of little use, since they could not keep the entrance of the port clear, or prevent the attack of torpedo-boats, without a floating defence consisting of torpedo-boats and armed local steamers acting as guard-boats.
4. That these fixed defences should be under military control, but that all the purely naval or maritime portion of the defences should be manned and worked by seamen under a naval Officer attached to the Staff of the General Officer in command.
5. To avoid, however, breaking up regiments into small detachments unnecessarily, certain small coaling stations abroad should be manned by marines and seamen and placed under naval control.
6. That the only way that our naval and military forces can be kept in their proper proportion, and used with the greatest effect, is to place them both under one Minister.

LIEUTENANT HYDE SMITH'S ESSAY. (See Journal, p. 445.)

Author's Summary of Conclusions.

(i.) Even if the main fleet sustain a defeat, the state of the enemy will not be such as to undertake an organized territorial attack in the face of Reserve or Flanking Fleet; consequently fortifications constructed to resist such an attack are unnecessary.

(ii.) Given an adequate naval defence, and proper organization of the land force as a *second line*, no enemy would risk attempting an invasion under cover of warships which had evaded our main fleets. That, therefore, fortifications to meet such a contingency are superfluous, and should not be undertaken.

(iii.) To a great extent, ports are protected by those ships which it is necessary to provide for defending trade in their vicinity. That in consequence, if it is a question of providing ships or ports, and both cannot be provided, the former should be preferred.

(iv.) Fixed defences are desirable for the naval arsenals and great commercial ports at home, to hold them against a dash made by ironclads, which had succeeded in evading our blockade, until such time as we could depend upon overtaking them with a superior naval force.

(v.) Similar defences are necessary for naval arsenals abroad. They should be on a much smaller scale than those in (iv), as not being open to attack from a heavy force despatched from Europe.

(vi.) Coaling stations and commercial ports abroad should be defended against one or two fast cruisers, which had succeeded in defeating the naval force keeping open the port. Allowance should be made for their having already fought an action.

(vii.) The cases of smaller commercial ports at home must be considered according to their relative importance; observing that an enemy's cruiser could blow in dock gates, and do much damage in half an hour.

(viii.) The defence of all naval bases and commercial ports should be under the control of the Naval Administration, and consequently the charges for them should be borne on the Navy Estimates.

Vice-Admiral Sir NOWELL SALMON, *V.C.*, K.C.B.: I can hardly claim to take any part in this discussion in the few remarks that I shall make. I feel, however, very great interest in the subject, and also in the writers of the two essays that are before us. Both of them served under me on two different stations, and it is very much on that account that I have come up here to-day and asked to be allowed to open the discussion. The two essays run on parallel lines up to a certain point, and then they diverge on a very important question. Taking first the prize essay, we have, I think, to thank Captain Craigie for having laid down for us a very concise and a very useful working scheme for the defence of the Empire and trade. He assumes that we should have a certain number of ships, which I trust we may have, and I trust also we shall have sufficient Officers and men to man them. That appears to be our difficulty at present, we cannot train our Officers and men so fast as we can build the ships. I hope that will come before very long. Under that head I should like to make a remark about the Naval Reserve, which our naval authorities are apt very much to trust to and to quote on all occasions where the sufficiency or insufficiency of the personnel of the Navy forms a question. I must say I do not think four handspikes and an old truck gun are sufficient to train a Naval Reserve man. With regard to the armament of the ports I have nothing to say, except that I agree with Captain Craigie that our coal depôts require an armament of a certain sort, but I do not think that they require to be made into Gibraltars. As a rule, a Royal Engineer does not like to undertake the fortification of a place unless he can go to all lengths, and he is quite right from his point of view. But, unless we lose the command of the sea, these fortifications will be called upon only for defence against desultory attacks, and if we do lose command of the sea no fortifications and no force that we can put in them will serve to keep those ports for us. To touch upon the minutiæ of the defence of the coaling stations, it is objected that the mine-fields are in the hands of the Royal Engineers instead of in the hands of the Navy. I suppose the reason is pretty generally known that when this was decided upon, the naval authorities said that they could not afford the Officers or men to undertake it, and I suppose if it were proposed to make the change now the same answer would be given, that we had not the Officers

or men to undertake it without a considerable increase, and that increase takes a very long time to bring about. The point on which the two writers split is that of the government and garrisons of the coaling stations abroad. One of them wishes to take under the naval command only the smaller stations, such as Ascension, the Falkland Islands, St. Helena, and such places, which we may say have no fortifications and no garrison, and require very slight ones. The other essayist, Lieutenant Smith, wishes to take under the naval charge all our distant coaling stations. As you will remember those not only form part of the Colonies, but are, many of them, at the headquarters of those Colonies, such as Singapore, Hong Kong, the Cape of Good Hope, and others; I think that is utterly impracticable. In the first place, if you are, as is proposed, to replace the garrison with Marines, we shall require not only the Infantry and Artillery that we already have, but we shall also require Marine engineers, we shall require Marine supply departments of all sorts and descriptions, and in some cases I am inclined to think we shall require what is now the mythical horse marine. Then again, even supposing that you have this Marine Force to garrison these ports, you have still a Governor in the Colony, and your Colonial Governor is by his commission also the Commander-in-Chief, and he will be in command, just as he is now, of the military forces. Therefore, from that point of view, I see no gain in the change. He would object naturally to the Admiral carrying off any part of his defensive force. There is another point which, speaking as a naval man who has been placed in such positions, I think a strong one. It is proposed that the Admiral, the naval Commander-in-Chief, should be supreme over the coaling ports, which are also the headquarters of Colonial Governments. I am inclined to think, speaking from my own experience, the Admiral would be very sorry to have anything to do with it. He would have quite enough work on his hands. He should be free to leave these places to the defence of those who are there for that purpose, and free to go where he likes. I doubt if any Admiral who ever commanded a station would wish to be tied down to it. As to the smaller places, such as Ascension, St. Helena, and the Falkland Islands, there is no real reason why they should not be under Admiralty direction, for the reason given by Captain Craigie, that is to avoid dividing up regiments into small detachments. Ascension is already a ship. There is not a soul on board of Ascension that is not receiving rations from the Navy, even to the milk. Falkland Islands is in the same condition. There is no population. The population that would be imported for the purpose could very easily be put under martial law. St. Helena, unimportant as it is and small as it is, there would be a great difficulty about. St. Helena has a responsible Government, and there is a population to deal with, and the Admiral would be mixed up with all sorts of questions foreign to his own business, quite independent of the garrison. I think I have said all I wish to say in introducing this subject to you. Both Officers are now serving away from England, and I wish to give them, in sailor's phrase, a "good send off."

Rear-Admiral BOWDEN-SMITH: Before I proceed to offer any remarks on the subject of these essays, I should like to join with Sir Nowell Salmon in congratulating the two Officers on the very excellent papers that they have given us. They are full of interesting matter, are fairly short and concise, and both Captain Craigie and Lieutenant Smith have evidently taken great pains in working up their facts. I am very glad to notice that both these Officers recognize the necessity of fixed defences for some of our naval ports and coaling stations, because I was afraid a certain class of Officers were agitating for the abolition altogether of such defences. But, though I believe in the necessity of fixed defences for certain of our naval ports and coaling stations, you will see from the remarks I am going to make, I do not go so far as those Officers do, and I should wipe out of the list some of the places they have mentioned. I shall confine myself entirely to our coaling stations abroad, for it is impossible to speak of everything in the few minutes allowed us. With regard to coaling stations throughout the world, I think the great point to be considered is that they should be on the main routes, and places, used by the mercantile marine under ordinary circumstances. I have two reasons for saying this: first of all we are sure to get good coal, coal that has not been kept long in stock; and we are sure to get that coal put quickly on board, because there are all the appliances for doing so and plenty of labour. Thus if you coal at places like Malta or Aden you get good fresh coal and

quickly delivered; but if you get coal at purely naval places, like Trincomalee in Ceylon, or Port Stanley in the Falkland Islands, you will often get very bad coal, which has been a long time exposed to the air. It may be said that is the fault of the Admiral on the station, but this is not so. For instance, taking the East Indian station, the orders used to be that the Admiral never should allow the stock of coal at Trincomalee to be less than 500 tons. Well, in making his arrangements for the coming year, he orders, we will say, 2,000 tons of coal for that place to supply the East Indian Squadron. Just after he has made these arrangements the whole squadron, perhaps, is called off to Burmah, or, as actually occurred the other day in Sir Edmund Fremantle's time, when the Zanzibar coast was attached to the Indian station, the whole fleet was on the African coast nearly a year blockading. The consequence is, in such cases, that the coal ordered out to the naval port remains there, and deteriorates in a very rapid way, especially in a hot, muggy climate like that of Ceylon; and I well remember on more than one occasion, after taking in coal at Trincomalee, the Chief Engineer coming to me and saying that he could hardly keep steam, the coal was so bad, having been so long exposed on shore, and was like so much dirt. Another reason why the coaling stations should always be on the main route is that these stations are not only required for coaling purposes, but they are also harbours of refuge, where our merchant ships can run for shelter in time of war if chased by an enemy's cruiser. Of course if they were off the main route they would not be so convenient for that purpose. We know that in some cases the naval port or coaling station does not and cannot coincide with the mercantile port; thus, for instance, Simon's Bay, at the Cape of Good Hope, though not a mercantile port, would become of such enormous importance in the case of the Suez Canal being blocked that we should certainly keep it armed and garrisoned as well as Table Bay. Having made these preliminary remarks, I will just run through our coaling stations of the East. We have first of all Gibraltar and Malta. Then, on the other side of the Isthmus, Aden, and Colombo in Ceylon, and so on to Bombay and Kurrachee, if we are going to India, or, if we are going further east, Singapore (our most important coaling station) and Hong Kong, the latter being our terminus in that direction. I suppose there is not much difference of opinion about retaining the places I have mentioned, although I do remember one Officer who read a prize essay here some time ago, advocating the giving up of Gibraltar, a place I should never relinquish, because, although the Suez Canal might be temporarily blocked, it would be a most valuable base for the protection of our trade passing to and fro the Cape and the South Atlantic generally. There is one other place mentioned on this eastern route by the lecturers, and that is Trincomalee, in the north-east corner of Ceylon, and that is one of the places I should strike out. It is off the main route, and is not used by the mercantile marine. It is certainly a fine harbour, but a fine harbour if it is off the route will never be used by the trade. The competition is too keen, and if a harbour is only 100 miles off the route merchant ships cannot use it. It was a very fine harbour in the old days when a ship wanted caulking throughout, and wished to refit her sails and rigging, but that is a thing of the past; there is no dock at Trincomalee nor plant of any kind for repairing machinery; therefore it is of little use, and men should not be locked up there. You may say that Colombo, about 200 miles distant, is rather a confined place, but although the port inside the breakwater is rather confined, the roads are extensive and safe in all weather. I have myself lain out there in a sloop during the south-west monsoon, and any quantity of shipping could assemble in the roads. Trincomalee should still be used in time of peace, but why waste our strength on fortifying an empty harbour? Let ordnance and other naval stores be kept at Bombay and Colombo, and let the latter be our only fortified position in Ceylon. I am now going to say a few words about the Falkland Islands, as they are marked out by one or both of the essayists to be fortified. I speak of these islands with some diffidence, because when the First Lord of the Admiralty made his usual statement this year in presenting the Navy Estimates, he hinted at the probability of one of the harbours in the Falkland Islands being selected for an armed coaling station. My reason for taking out the Falkland Islands from our list, as not necessary to have fixed defences, is that they are off the main route, and are not used by ships of the mercantile marine, unless

driven in by stress of weather or some other cause. I know the Falkland Islands well, and have passed many pleasant days there, and for the sake of its hardy inhabitants (the population is about 2,000) I wish a naval station could be established there, but we must consider Imperial interests and not individuals. I am aware that the islands possess beautiful harbours, though somewhat shallow, but the Colony will never be of sufficient importance to warrant our having anything like an armed station there. The communication with the Falklands is very indifferent, being limited to about one steamer a month, and there is no cable to Port Stanley, so that when there one hears little or no news from the outer world, and telegraphic communication could only be established at the expense of the Imperial Government. I do not suppose the islands would ever carry more than one million sheep, and that amount of wool is, of course, a mere bagatelle compared with that imported from other places. Gentlemen may say, "That is all very well, but how are we to guard that trade route through the Straits of Magellan and round Cape Horn in case of war, and how are we to supply coal to our cruisers?" My answer is, if we are to have cruisers down in that part of the world we must either have cruising colliers with them or colliers sent to meet them at arranged rendezvous, and I believe that will have to be done in war-time much more than we now imagine. I know no part of the world where you could more easily transfer coal from colliers to cruisers than on that station. All down the coasts of Brazil and Patagonia there are plenty of uninhabited bays and headlands, in which, or under the lee of which, you could transfer the coal quite easily from the colliers to the cruisers without anybody being present to say no, or talk about international law, Or if you find it absolutely necessary to have a coaling station at the Falkland Islands during a war, you might send a small naval expedition out, and occupy one of the harbours temporarily. That would be a far better plan than locking men up to deteriorate in that out-of-the-way locality. We had a lecture last week on torpedo-boats, and we have had lectures on naval warfare generally, and we are very much obliged to any gentleman who will take part in the discussions; but I have often thought that on such subjects we are rather talking in the dark, because we have had no naval warfare since all these modern inventions have been introduced. But when we speak of our trade routes and our food supply we have the most valuable statistics to help us, which are all of interest to Englishmen generally, and to naval Officers particularly. I allude to the Board of Trade Returns, and there we can see where our principal imports come from, and which will be our most important trade routes and coaling stations, and those that we ought to protect at all hazards. I suppose you will all agree that our most important imports are bread-stuffs and raw material for our manufactures, and of those raw materials I suppose two of the most important would be cotton and wool. Referring to the Board of Trade Returns for 1891, I make out that no cotton comes to us by the Cape Horn route. With regard to wool, there is no doubt that the wool from New Zealand comes by the Cape Horn route, but I think all the New Zealand wool and other exports in time of war must be diverted to the Cape of Good Hope route, that route being rendered absolutely secure for the whole of the Australian trade. It would be rather longer I admit for New Zealand, but regulation in war-time must be submitted to. With regard to bread-stuffs, and speaking only of wheat and flour, we find that wheat comes from Russia, Turkey, India, Australia, and many other places; and it also comes to us largely from the United States. And here I am going to say something which may appear at first sight against my argument, because more wheat comes from the western seaboard of the United States than from the eastern or Atlantic seaboard, and that from the western coast does, doubtless, come to us by the Cape Horn route. Thus, last year the wheat imported from the Pacific ports of the States was over ten million hundredweights, whereas from the Atlantic ports it was only six million hundredweights, but with regard to flour, which I may call manufactured wheat, we received nearly eleven million hundredweights from the Atlantic ports, and only one and a quarter million from the Pacific. Taking wheat only, I make out that one-fifth or one-sixth of the whole quantity imported probably comes by the Straits of Magellan or round Cape Horn. Perhaps you will say if that is the case, it is an important quantity, and that route must therefore be secured, but you must recollect that in war-time high premiums and war

risks would prevent wheat being sent by this long sea voyage, except in neutral bottoms; and a great deal of that wheat and flour which is now shipped from the west coast would find its way overland to the east coast, and be shipped from thence. Not only that, but in the distant future we shall get less wheat from the States. Every year the population of the United States is largely increasing, and they will require more of their own bread-stuffs. Other parts of the world will be able to supply us, for instance, the Argentine Republic is already beginning to send us a considerable quantity, increasing every year. Other routes also will be opened, for although the Panama Canal is virtually abandoned, there have been already sixty millions sterling sunk in it; I believe the Nicaragua Canal will probably be accomplished, as the estimate of twenty millions sterling for its completion is a moderate one. I maintain, therefore, that the Cape Horn route is not one of the first importance to England, and we should not commit the mistake of erecting fixed defences at the Falklands to protect it. My friend Admiral Colomb read a paper here, about a year ago, on the subject of fixed defences, which rather alarmed me, as I thought he advocated giving up all such defences, even at important coaling stations; but from what has from fallen from him since, I am inclined to think I misunderstood him, and that he merely means to say we should reduce them as much as possible, and not to have more men locked up than we can possibly avoid. If so, then I am with him. With regard to trade routes generally, what I maintain is this, I would far rather have three trade routes efficiently protected and properly patrolled than four or five inefficiently protected and improperly patrolled. As to the garrisons, I think all the large fortified stations should be held by our military forces as at present, as we could not afford to have our seamen or Marines locked up by thousands in such places. They get little enough sea service as it is, and in that case some of the men would get none at all. But with regard to the smaller places, I should be very glad to see some of them garrisoned with Marines and Marine Artillery, both those splendid corps being proportionally increased.

Colonel MOODY, R.M.L.I.: The very important essays which are before the meeting call for the most careful and deliberate discussion, because the keynote of the whole is really and actually how to obtain the maximum value out of our existing (and immediately probable) means of defence. Both essays show a very masterly grasp of the subject, and have dealt with it on good broad and common-sense lines, but there are some matters touched upon by Captain Craigie which appear to me to require a little further elucidation, and which deserve some rather close criticism lest the power and capability of one branch of the Navy, the Royal Marine Corps, should be overlooked in considering the question of Imperial defence, a result which I feel sure that Captain Craigie did not wish, as evinced by the way in which he has spoken of the corps. On points 1, 2, and 3 of those laid down for discussion I propose to offer no observation, as, though not by profession a naval strategist, I cordially agree with Captain Craigie; but on points 4 and 5, those being the points on which, during thirty-seven years' service, I have thought much, I should like to offer some observations. Point 4, I do not agree with Captain Craigie's suggestions as to the naval fortresses, with the exception of the main ones such as Malta and Gibraltar. I think that for maritime fortresses naval control is the best. I cannot see how the Admiral on the station would find his hands tied any more than the Commander of a field army based on a fortress finds his hands tied by the requirements of the defence of the fortress. I cannot imagine, as stated in the discussion, that any friction would arise between the Governor of the station and the Admiral with reference to the Marine garrison if the Governor was independent of the Admiral. It appears an anomaly in England that the Marines on shore should be under the command of the General Officer Commanding for discipline, but it works well, and has stood the test of many years' experience. A localization of torpedo-boats and harbour defence craft I think admirable. The placing of the submarine defence *at all ports* in the hands of the Navy I think essential, though I am fully aware of of the difficulties in the way of such a course in the present state to which the question of harbour defence has been brought. Submarine mining is not, I understand, a popular branch with the Royal Engineers, and it is scarcely a judicious measure to give the Army sole control of the mine-field through which the Navy must thread their way. The submarine mining and

all harbour defence might well be performed by the Royal Marines, assisted, if need be, by the Militia and Volunteers, and the naval system of mining should be adopted. It appears out of the question to expect the country to vote upwards of 49,000 men for the defence of their coaling stations, nor should a standing force of this size be required. At most stations the ordinary garrison should only be a nucleus, who should be employed to train the local forces already in existence or who should be raised, and who should be called out as required. I cannot imagine a more suitable body to carry out this training than the Royal Marines. It is well known that they get on well with those with whom they are thrown in contact, both in and out of the Service, at home and abroad. I need not remind the majority of this meeting that it is only the individual and conscientious care on the part of the Officers and non-commissioned officers which turns the raw recruit into the highly and carefully trained marine whom we embark. Ship work gives self-reliance and adaptability, but it would be of little use if the shore-training were omitted. The same individual training could be given to the Colonists, and thus, without unduly drawing on the resources of the mother country, the Admiral would always be confident that his base was safe, since he would know and have the control of the forces to which it was entrusted. He need not have any anxiety as to having to work out military problems, for he has Marine Officers whose business it is to do this, subject to his approval, and he will, I am confident, find them just as efficient and up to the mark as fortress Commandants as any Officer in Her Majesty's service, making no exception whatever. Captain Craigie has told us that now the *bonâ fide* seamen number 20,000. The Royal Marines number 14,000. Both branches, the seamen and Marines, are highly trained; but I maintain that the country does not get its full value of the Marines. This corps is capable of economical and rapid extension. It is cheap and very efficient; it can be largely increased without in the smallest degree impairing its efficiency as a naval force. At coaling stations, there being a nucleus, the force could take their turn for sea in the ships on the station, being relieved by a similar number afloat; thus the difficulty mentioned about sea training could be overcome. The Fleet are more likely to be increased than the coaling stations. The Marine submarine miners can be embarked or not as required. Thus, by placing the coaling stations under naval control, and employing the Royal Marines to man them, you will increase the efficiency of the corps, which will then have a future, as at present I am tempted to fear they have not, and last, but not least, the pocket of the country will be spared. In conclusion, I would say, think on these facts, and do not overlook this branch of the Service, but let the corps, which is proud of its connection with our glorious naval history of the past, have a more pronounced share in the naval history of the future, a share for which they have honestly striven to qualify themselves by steady discipline and patient perseverance, turning their hand to anything required, and keeping well abreast of the professional changes of the past half century, that they may be well able when the struggle comes to bear their part in the defence of this great Empire. To send them to the minor and out-of-the-way coaling stations only would be a grave error; it would be better to keep them out altogether.

Commander SULIVAN: I should not have taken any part in this discussion had it not been for the attack made on the Falkland Islands. Having been the first person born there under the British flag, when General Moody was the first Governor, I naturally take a great interest in the place, and know something about it, and I rather think Admiral Bowden-Smith has under-rated rather than over-estimated the number of inhabitants. The whole of the land is taken up by settlers, and one company alone pays 27 per cent. on its 100*l.* shares, which cannot be purchased under 250*l.*

The CHAIRMAN: That is not the point of this discussion.

Commander SULIVAN: I will go on to the importance of the place as a coaling station; but Admiral Bowden-Smith said the place had not sufficient trade to make it of importance, and I wish to show that that is not so. Another point is, it is the only place, I think, between England and New Zealand or Vancouver's Island on that route that is in the possession of the British Government. The South-east coast of America Squadron will require a place for coaling, and there is no other place they can go to in case of war. They could not, in the case of war, go to a foreign

port for coal, and the Falkland Islands is the only port that they could coal at. There is already a force of Marines at the Falkland Islands, which might be augmented, and, as Admiral-Bowden Smith says, there are splendid harbours of every sort. I do not think the Falkland Islands could be left out of the list of coaling stations.

Admiral LONG: Sir Vesey Hamilton, ladies, and gentlemen, there are one or two points that I should like to remark upon in these essays. I think the Institution and the authors are both to be congratulated on the great amount of information and the way it is put together in these essays. I have read them with great interest and profit. To begin with, the preamble states that the supremacy of the Navy is the great point, and I think that most probably what is at the root of the whole of this matter really is that the supremacy of the Navy means an offensive policy on the part of the Navy—the first thing the Navy has to do is to attack—a policy of attack, and therefore the question of defence will undoubtedly only take second place. I agree generally with the author of the prize essay in advocating the maintenance of the present state of affairs, that is to say, that the shore defences should be in the hands of the military. Everything on the sea should be in the hands of the Navy, and where the sea and the shore come in together, then I believe the Marines will give their very valuable assistance, and the more we have of them the better. There are one or two points of detail that I might refer to. Captain Craigie refers to the "Royal Sovereign" and the "Centurion," where he advocates more vessels being built. This is a subject of such very great importance that I do not like to let it pass without saying one word. It appears to me that there is a misapprehension in what he says with regard to the "Royal Sovereign" class as being too big and too complicated, and that there is "a growing feeling against these unwieldy monsters." Now a large ship is by no means necessarily a complicated ship, neither is she an unwieldy ship. I wished to say this because it might go forth from this Institution that a big ship should not be built, and that she is complicated and unwieldy. Probably Captain Craigie is right in the argument, but the reason that he has given is not a sound one. If you say a big ship is equally likely to be destroyed by an 18-inch torpedo as a smaller ship, then I think you have a very strong argument against big ships. The 3rd point in both authors' summary of conclusions is "That these fixed defences are of little use, since they could not keep the entrance of the port clear or prevent the attack of torpedo-boats without a floating defence" in the vicinity. We must remember, in the event of war, our large mercantile ports will need vessels in the offing, and I think it is a great question whether these vessels should not be manned and controlled entirely from those ports; I do not see why they could not be. I believe the principle of decentralization and local organization is most important in an Empire like ours, and that if ports like Liverpool, Glasgow, the Tyne, Hull, and perhaps some others, were furnished with suitable vessels, and the control of them placed in the hands of the superintendents of great companies in those places, in the same manner in which the railway system of the country is meant to be worked in time of war, you will find by getting the local talent and of course local interest, which is far greater than any other interest in such a matter as that, you will strengthen the country very much. Sir Nowell Salmon remarks that truck guns and handspikes are not the things to train the Naval Reserve of the present day. I cordially agree with that, and I think, if you will look at the Report of Sir George Tryon's Committee, and will read the list of vessels, the drill-ships for the Royal Naval Reserve, you could not but wish that instead of those vessels he had really sea-going fighting vessels. If those vessels were placed at ports, and placed more or less under the control of local people who had a direct interest in the matter, and who are all exceedingly practical people, I believe they would do well. Of course the Coastguard ships will be all withdrawn, I presume, when war breaks out. We have a Coastguard which, I have understood, is to be withdrawn for general naval service in such an event. In the same way the fixed defences should be in the hands of the Army. Lieutenant Smith says that it would be a good thing to put these into the hands of the Navy, because, when war breaks out, you would then have a lot more men to send afloat. It seems to me that that is putting the cart before the horse. The object of organization for the fixed defences is to have people on

the spot who are always doing the thing, and I should go in myself for the permanency of the personnel of the fixed defence, and I should give control locally. I think that that would be the most practical method of doing it; although I quite admit that our sailors and marines would do it quite as well as anybody else, perhaps better. I am still of opinion that the Royal Engineers would do it quite well enough, if Royal Engineers or artillery are always doing it and are not taken away directly war breaks out. It must be evident to everybody that whatever is said in this theatre in favour of altering the existing system of affairs is likely to carry exceedingly little weight now when we are looking forward to a general election; but anything which is said here which may in any way conduce to the more effective working of the system that already exists, it appears to me may be of some use, and I should like to say that those defences which already exist, which are now organized, should be tested a great deal more than they are, by combined action between the Army and the Navy. There is unity of spirit between the two Forces, and it wants to be put more in practice. If that were done more than it is, certain ludicrous facts which are known to many people would not exist; the mines of defence would be in the proper place, and not in the wrong place, and whatever corps may execute the work of installing a mine-field, the plan of it and the locality it is to occupy, should receive the concurrence of the Hydrographic Department of the Admiralty. If that were done, there could not be such a thing as putting a mine defence in the wrong place. It is very often said "a bad law well administered is better than a good one badly administered," and our present system, which I admit is utterly illogical, may act uncommonly well in war. We are accustomed in this country to get on in that sort of way, and I think perhaps we may go on doing so without disaster, if practical co-operation between the Forces can be insured.

Major G. CLARKE, R.E.: I cordially endorse all that has fallen from the previous speakers as to the excellence of the papers under discussion. I think the prize essay, especially in the arrangement of the matter, the clearness of the style, and the business-like way in which the whole subject has been treated, reflects the utmost credit upon the writer. I am the more glad to say that because I find that I disagree with most of his conclusions. In the first place I cannot believe in handing over torpedo-boats to Volunteers; it seems to me that is the very last weapon we can entrust to amateurs. In the second place I see Dover is classed as a first-class naval port which an enemy would make great sacrifices in order to injure. Now I have not the slightest idea what there is at the present time to injure at Dover, except the Lord Warden Hotel. It is perfectly true when you get your harbour there, which I only hope you will get one of these days, there will be a case for some moderate defence of Dover; but at the present time we have large defences at Dover, but no port, and those defences seem to me to be at least premature. I have not in fact the slightest idea how Dover came to be fortified at all. Here is the opinion of the Duke of Wellington on this point. When he was asked by the inhabitants of Dover to increase their fortifications, he wrote, "The fortifications of Dover would be no doubt very useful if the enemy came in that way, but I do not think he would. They might also be very useful if the enemy went out that way, but I do not think he would." That was the opinion of the Duke of Wellington. I also find that in the Prize Essay our old friend, the Minister of Defence, crops up. I did hope the Report of Lord Hartington's Commission had gone far to kill that double-headed hydra. I do not know what the effect of such an office would be upon the Army, but I am certain it would be disastrous to the Navy. In the "Pilgrim's Progress" there was a certain Mr. Facing-Both-Ways, whose career, as far as I remember, was not successful: I do not think he got very far on the road to the Happy Land. But what I differ from most in the Prize Essay is the enormous increase of expenditure involved, and the great increase of defences which I consider already exaggerated. One other comment before I pass from the actual matter of the Essay. I find that though something is stated about geographical conditions as affecting the standard of defences of ports, yet places such as Belfast and the Mersey are placed in the second class. Those two ports are almost in interior waters. It seems to me if naval supremacy is to have any special value, it is in such waters as those, which can be easily watched. They are in a totally different position from others, and

they need not be placed nearly as high as the second class. Then I find Madras, which I did not know was a naval or a great commercial port, is treated on the same footing as Singapore, which, in my opinion, is the most important strategic point of the Empire. Then again, Calcutta, which it seems to me is amply provided with defences by nature, receives fortifications, whereas Rangoon, which is very much more accessible, gets no defence at all. I think the whole point really is one of scale. Admiral Colomb, we know, is looked upon as somewhat of an iconoclast in regard to fixed defences generally. I do not, however, understand him to have said that fixed defences were useless; all he objects to is the scale which has been adopted, and in that I agree with him. During the last thirty years, as far as I can make out, we have spent something like twenty millions upon fixed defences; besides that, of course there are charges which one cannot possibly estimate. If you once get your standard wrong, it involves an increase of annual charges which nobody can put into figures. As to the difference of scale which two men approaching a subject can adopt, I remember a case of an estimate being made for the defence of one of our ports abroad. The expense was put at 332,000*l.* by a military Officer. The same port was afterwards estimated for by a naval Officer, who also went to the spot and investigated the matter, and he asked modestly for three 5-inch guns, so that in the one case the cost of the defence would be 20,000*l.* and in the other 332,000*l.* That shows how the scale may vary, and the enormous difference that the point of view makes. Both these Officers were doubtless right, only they looked at the thing from a different point of view. Can we not lay down one distinct proposition that in all questions of this nature history is our only guide; and thus anything else must be more or less speculation? I think you will find that we are not altogether without modern experience which gives us every reason to believe that the past will repeat itself, and that we may absolutely rely upon the teaching of the old wars. For instance, there was the action at Lissa, in which smooth-bore guns, without any great difficulty, completely repulsed an armour-clad fleet. Then we were much astonished at Alexandria, at the large amount of ammunition expended in silencing the guns on shore. Exactly the same thing happened in 1704, when Rooke took Gibraltar, which had a garrison of only 150 men. He so far depleted his ships of ammunition that he actually risked the loss of the battle of Malaga which followed, an action of the greatest importance. Coming to last year, you have the little Chilian war. Valparaiso was a place heavily fortified, but nobody ever looked at the fortifications there. The Congressionalists simply went round them. To take Valparaiso, it was necessary to defeat Balmaceda's troops. They, therefore, simply landed at Quinteros Bay and went straight for those troops. If there had been only half a dozen guns at Valparaiso, it would have been exactly the same; they would have been left alone. I think one false standard of defence has, in a great measure, arisen from want of a scientific study of history, and I wish particularly to say a word about what I may call the decoy argument, which is a very favourite one. It appears in the Report of the Commission of 1859, and runs right through the remarkable letter which Lord Palmerston wrote to Mr. Gladstone on the subject of fixed defences. Since then it has appeared in books, newspapers, magazines, and in this theatre, and it will probably go on appearing at intervals. How does this decoy theory arise? Entirely out of an utter misrepresentation of the events of 1805. Popular history describes them somewhat in these words, "Nelson was a great fighting man, but withal a very simple person. He was watching Toulon: the French got out, and they led him a wild-goose chase to the West Indies, where he foolishly followed them, returning only just in time to fight at Trafalgar. The fate of England trembled on a mere chance. If the winds of the Atlantic had been contrary, England would have been lost." That is the history we teach to our boys. What are the facts? On the 25th of April, 1805, the Admiralty wrote to Lord Nelson and told him that a specified force—and they specified the smallest details—had sailed from Toulon, and that orders had been sent to the "Queen" and "Dragon" to go from Gibraltar to Barbadoes, "provided your lordship has not detached from under your command a number of ships equal to that of the enemy which passed through the Straits on the 9th instant." The Admiralty trusted that Nelson had already detached those ships. Nelson never got those orders. He

went after the enemy, as any British Admiral in his circumstances would have done. I do not suppose that the Admiralty had completely fathomed Napoleon's plan, but they fully provided for every contingency. They provided for the reinforcement of the West Indies in case Nelson had not detached a force to go there, and they provided for the gathering together of their forces in the Channel. Nelson returned, but, before he reached home waters, Villeneuve had fought the action with Sir R. Calder, off Finisterre, and there to an inferior squadron he lost two ships. Was that the kind of force which was going to clear the Channel and make way clear for the invasion flotilla? The fact is the French had not the slightest chance of invading England in 1805, and this was not due to fixed defences, but to the British Navy. Napoleon never meant to invade us at all; he had an army to create, and by creating it on the shores of the Channel it answered the double purpose of being organized to crush Austria, and at the same time hampering the action of our Navy. In that he succeeded, and the success went no further. I have laid some stress upon this decoy theory, because it seems to me one of the stock arguments now advanced in favour of an exaggerated standard of fixed defence. The decoy argument has had a long life and has done a great deal of harm. I think we might now give it decent burial and have done with it. What does naval supremacy mean, and command of the sea as laid down as the postulate of the essay? It means that you want to bring on a fleet action and the enemy does not. It means that in time an enemy's ships will be mainly collected in his fortified harbours. It follows that those harbours will be, not blockaded, but closely observed, and ships escaping therefrom will be followed up. In the long run it means, if maintained, the gradual disappearance of the enemy's ships from the sea. Meanwhile there is no sort of naval strength that we could possibly provide in this country which would absolutely guarantee, especially during the first few months of a war, that the enemy's ships, single ships, or in pairs, might not move about the sea. Such ships might attempt raids on undefended ports, and it is against those raids—mere raids—that fixed defences are required. The analogy from military matters seems to be just this: A powerful army is advancing into an open country; the enemy has a considerable light cavalry force, small parties of which may find their way through the advancing columns or round their flanks. The General in such a case does not wait to build fortresses to protect his communications: he simply makes a few light defences against cavalry raids. That seems to me to supply some idea of the standard of fixed defences necessary for the British Empire. The reply is always "Oh, but you have not got the necessary naval strength!" Then let us stop every single penny of expenditure on our fixed defences until we have got the necessary naval strength. We must have a Navy, and a powerful Navy, to maintain our supremacy at sea. If we have not got that Navy, the Empire cannot be defended in war even if every port is made impregnable. Given that absolutely necessary Navy, what remains for fixed defences to accomplish? That is the question, and I do not think in the prize essay the full effect of naval supremacy has been taken into account. It seems to me that the writer was led away by the fascination of fortifications just as some of us have been led away, and goes a little further than we have done. Coast defences are generally spoken of *en bloc*, but practically they can be divided into two parts: first, guns and mines required to deny certain waters to ships; and, secondly, garrisons. History shows that ships were always shy at facing the fixed defences of European Powers; very small fixed defences have always served to keep them off. On the other hand, navies, and our own Navy especially, have been very ready to make land attacks against which garrisons had to be provided. The reason is obvious; nearly every place has its back door: why on earth go and knock your head against fixed defences, when you can go in the other way, and when you must go in the other way in most cases in order to effectually occupy and use a harbour? It is wrong to suppose that by merely bombarding a port you can go in and use it. You cannot go in and use it unless you have landed and defeated the troops on shore. That is where the question of garrison comes in. The exaggeration which has occurred with us takes the forms of putting in far too many guns and mines. In some cases I think we have starved the garrisons. In conclusion let me make one appeal to the Admiralty. If you will not take the responsibility for fixing the

standard of our coast defences, will you not lay down some few authoritative data on which we can act? It we do not accept those data, then pitch into us; but if we have no authority to guide us, it must be that we shall sometimes run into excess, and then you come and tell us that we have spent the money that you need for the Fleet. Let me take one illustration. There is the case of the River Thames. Will you lay down for us whether it is reasonable and probable to expect that an enemy's battle-ships are coming up that narrow river as far as Gravesend? See what depends upon this? If they won't come up, then what do we want with all those armour-piercing guns that we have on the Thames, what do we want with the mines and the Brennan torpedoes? See the difference it makes if we have that one single point laid down for us. Oliver Wendell Holmes has told us that the Romans won the world with the short sword, and lost it when they adopted the long one. It seems to me that this provides a lesson for us. The short sword means getting close to the enemy, getting as close to him as you can; the long sword means waiting behind defences for him and prodding at him. We won an Empire and we maintained it against the world when we adopted the policy of the short sword. If we adopt the policy of the long sword; if we wait behind fixed defences for the enemy to come to us to be shot at or blown up, then we shall certainly and deservedly lose an Empire such as the Romans never swayed.

Admiral COLOMB: I should like to join my congratulations with others to the authors of these most admirable and lucid papers. Besides the way in which they are drawn up and prepared, they show, I think, so distinctly an improved opinion, that we congratulate them and congratulate ourselves and the Institution on the change. I think the first thing we may note is, the recognition that the defence of this Empire is naval and military; that it is not, as it used to be said, that the Army is to be left alone to defend the ports and forts, and so on, and that the Navy is to do something else not defined. I think it is now better understood that the two Services work together; did work together in the past, and will work together in the future. That is the pith of these essays, and, in consequence, in them you have no claim put forward to fortify places on the understanding that there is no Navy possible to help in the defence. That, I hope, has passed away for ever; but it has been distinctly laid down, over and over again in the past, that the scale of fortifications should be governed by the idea of an absent and helpless Navy. Nor shall we have again, I think, an author like Sir Charles Dilke inferring in his work that, when an Officer commanding a distant station says he has no doubt he will get on very well with the assistance of the Navy, he is in a bad way. Those were Sir Charles Dilke's inferences in his former books, but his later books seem to say little in that direction. There is shown in these essays, too, a better estimate of the time element; how the time element governs the possibility of attack, and how, unless the circumstances allow not only time enough to do the work that is to be done, but an immense margin besides, the enemy will not make attacks. But I am not quite clear in my mind as to the way in which the prize essayist has looked at the problem set before him. The question is, as I have read it, "How far maritime supremacy requires the assistance of fixed defences?" or, to put it in another way, "Can maritime supremacy be established without fixed defences?" or else you may take it that, "Maritime supremacy being established, should fixed defences be added?"—for, I suppose, for convenience—or it might be taken, "Are we to defend, by fixed defences as necessary to support an inadequate fleet?" or, lastly, "Are we to defend, by fixed defences in case the Fleet should be beaten off and destroyed?" As far as I understand them, both essayists have taken it that maritime supremacy is established, and that the question of the fixed defence is more than ever one of convenience. There is another way of looking at the problem. You may ask whether your defence should be to meet occasional lapses, which I think is the point that Major Clarke has addressed himself to. And there I find we are in agreement. I think we must look forward to maintaining our Navy so that it shall not be driven into these ports. That is to be our policy, at any rate, and then it follows that it is only occasional lapses of the naval force that need be provided for. But I think both essayists ought to have argued this question out; I think they ought to have taken it whether, as it has been constantly said, if we have fixed defences, the force of the Navy need be less con-

sidered. I am sorry neither essayist has taken up that point, because I have no doubt it would have been well dealt with if they had done so. We must also consider the question whether we are to be ready to resist an attack when made, or whether we are so to act, that attack cannot be contemplated? We certainly can look at it from those two points of view, and, if we depend too much on fixed defence, we must recollect that the enemy can calculate very accurately what he will have to meet, and, therefore, he is the more ready to contemplate attack in such cases; but he cannot calculate so easily the value of a threat which may be offered to him by a force brought together on the spot in case he makes an attack. And it seems to me that history always shows us that the value of that threat is overwhelming. We know the strength of a fixed defence can be measured, attacked, and overcome. We know how often that measurement was not made, because the real strength of the place was the likelihood of a relieving fleet arriving before it could be subdued. Unless the enemy—so far as I understand—is sure against interference while making his attack, he will not make it at all, and he will not only want that assurance, but he will want a great margin of safety before he does it. In any case, some principle is required for determining the amount of fixed defence, and Admiral Bowden-Smith and Major Clarke do me no more than justice in pointing out that I never for one moment contemplated the idea of abolishing all fixed defence. The only point I strove for, together with others, was not to waste our money too much on fixed defence. I do not think the prize essayist has drawn as much distinction as he might between actual fixed defence and localized defence. I look upon the two things as different. He takes them, you will observe, together, as if movable defence, which was localized to the place for the time, was exactly in the same category with works which could not be moved. Although the essays are both most able and lucid, yet, if you read through the conclusions that both essayists have come to, you will see enough discrepancy to lead us to understand that they have not fully or precisely grasped the whole of the subject, and I must say I think most of us—and I certainly am myself—in the same condition. I do not think that we have got quite to the bottom of it, though I think we are nearer the bottom than we used to be by a long way. The trouble of coming to a wrong decision in the scale of fortification, as Major Clarke has put it, is that we shall either waste our money in exaggerating the scale, or else we shall leave ourselves weak, when we might make ourselves strong for the same money. I think that both essayists, so far as I can make out, do assume the possibility of the maritime supremacy without any fixed defence whatever. That is what I gather is in both their minds; but they think this maritime supremacy might be touched a great deal, and damaged, and a great deal of injury might be done, if you had not a proper proportion of fixed defence. In dealing with the question of localized defence, Admiral Long adverted to the point, as I thought, very justly. The essayists, though advancing towards it, do not seem to have gripped the whole of its consequences, and, therefore, there comes such a curious discrepancy as you find between the first and second conclusions of the prize essay; where the prize essayist, in the second paragraph, clearly supposes a blockade, lasting for days, on some of our ports, and, of course, that blockade is not affected by any amount of fixed defence, but it does not show that maritime supremacy, so far as that place is concerned, has gone for the time. The question of torpedo-boats has been brought into the subject. I am sorry the essayists did not stick entirely to the fixed defence—not going into the question of submarine mines unless they are part of the localized defence. The prize essayist takes a very curious view, I think, in assuming that the enemy will be quite prepared to sacrifice his whole force in attacking a certain port, because of some advantage that he would gain by making that attack. Now, my argument in these cases is always that mankind remains precisely the same from age to age, and I do not know anywhere, in times past, of any nation sacrificing the whole of its force for the purpose of doing something, except in the case of fire-ships and explosive-ships, neither of which ever came to much good. I cannot, therefore, bring my mind to conceive any navy sending a large and valuable force, such as that of several ironclads, on the chance of doing as much damage as the loss of those ships would cost him and no more. The second essayist seems to me to sin a little in the same way in assuming a dash by the enemy's ironclads

against certain of our ports at home—I think he must mean in such a case the enemy will be prepared to make some sacrifice. The point that dwells upon my mind in all these cases is that we have not settled upon what is to encourage the people to make attacks of this kind, which they never made in times gone by. Are modern ships going to do a great deal more damage with a great deal less risk than was the case with ancient ones? I see nothing in modern conditions to encourage the sort of attack which is contemplated. In all cases it certainly was the threat, and not the fixed defence, which prevented attack—I won't say in all cases, but in most cases it was the threat which kept the enemy from contemplating the attack. The great difficulty is, what principle are you going to establish in order to regulate the scale of your defence? and Major Clarke has shown us how widely the authorities differ on this point. We want some sort of principle by which we should say how much is right, and how much beyond that is wrong. We should then certainly have advanced to a great extent. I think both essayists—but especially the prize essayist—seems to set up two standards, which, to my mind, are antagonistic. They seem to set up first the principle of geographical conditions and facility for attacking the neighbourhood of an enemy's ports, and so on; and then, on the other hand, the greatness of the prize. Portsmouth and Plymouth are to be attacked because the prize would be so great there; other places abroad are to be attacked because they happen to be near a possible enemy's port. I myself am rather inclined to think that, if we have our proper supremacy, the point is the amount of force the enemy can bring to bear, and, although he may wish very much to attack a very valuable prize, that he will not be able to get any more force out to do it because the prize happens to be valuable. It seems to me the enemy would be exactly in the same position whether he were going for a small or big place, that he would be able to get out so much force and no more, if we were doing our duty properly, and, therefore, logically, I think we do not want more extensive fixed defences merely because the place is itself more important and would be a greater prize. I agree very much with Major Clarke in what he has said, namely, that the first thing to be thought about is the garrison. If we fix our garrisons, we should then fortify merely to increase the defending power of those garrisons, and especially with regard to attacks through the back door that have been referred to. I do not agree to the principle we seem to have adopted of massing our heavy fortifications, so as to protect from a sea attack, which history tells us is very unlikely indeed to be made, while the back door is to be left comparatively open. We should commence by saying, for such a place we shall establish such a garrison, and then that we will put such works there as will enable that garrison to hold its own against some larger landed force—twice the force, or whatever it may be—for some limited time; but the prize essayist, I suspect, is increasing and not decreasing the amount of fixed defence which is now allowed. His garrisons amount to 42,900 men, which, for this country, is a large force to lock up, and I should be inclined to hope that it might be somewhat reduced. Of course I am only now addressing myself to a few general principles: it is quite impossible to go into details. But the point I have in view, as regards defence, is this: that I note how our naval force has been distributed in previous wars, and I am pretty well satisfied that it was the almost universal rule to localize ships, to attach them almost permanently to ports, for the purpose of keeping them open; and my strong belief is, in war—let the Admiralty say what it likes, and let us all argue as much as we choose—that the localization of naval force to protect the entrance to a port, and to protect the ships trading in and out of that port, will be a primary measure, and that we must always assume so much naval force present, and begin with that. The naval force that you are going to have at each of those ports is the beginning of the whole thing. Then you get your garrison behind, in order that the enemy may not come round the back way: and then you build your fortifications, that they may defend themselves should the enemy come round the back way. But I think, if I had to write one of these essays, I should have liked to have begun from a totally different point of view. I should like to have begun with the possible forces of the enemy, the coal endurance of their ships, what they can do in landing men, and so on. Then we should see what it was we were open to. They must have coal, they must have stores, they must have bases. They cannot drop from the

clouds into an immediate attack, and they can never calculate now, on not being interfered with. Having ascertained the sort of attack, and the strength of the attack, which it is reasonable to expect, we might establish our localized naval defence—and when I speak of localized naval defence, I find myself coming round more towards regular sea-going men-of-war than towards the kind of defence that Admiral Long has spoken of, which is not perfectly sea-going.

Admiral LONG: Perfectly sea-going; I repudiate anything else.

Admiral COLOMB: We are agreed then. If that is so, you then have your perfectly sea-going force there, and which you would draw together, in the first instance, by an examination of the enemy's powers of attack, and then have your garrison, as I have said, and your fortifications, as far as they were sea-faced fortifications, would simply be supports to the naval defence, in precisely the same way as the shore fortifications would be supports to the land defence. If you approach it in that way, one gets towards the arranging of such a scale as Major Clarke so properly desires. Passing, however, to just one detail or two, I may say that both of the essayists give up the Mediterranean route, and it is common to give it up. For myself, I cannot possibly understand our thinking of giving up that route. It seems to me—I do not like to use strong words, but I must—the rankest nonsense. The prize essay goes a little beyond what we generally do. I can possibly understand our saying, "Give up the Mediterranean, if you have not force enough to hold it. Drop it and go to something else;" but the essayist goes further than that—he says we are going to hold command of the Mediterranean, but not because of the only possible object of our holding it—to protect our trade. We are to give up our trade, and, if so, what is the use of our fleet, except to protect Malta? We are to give up the mercantile route, and send the whole of our merchant ships, to the awful loss of this country, round the Cape, because we cannot protect the trade. If we can hold the command of the Mediterranean, we surely can protect the trade, and with coaling stations at Gibraltar, Malta, and Port Said, it seems to me the simplest thing in the world to do. I wish neither essayist had touched upon that subject. Then on the question of control—that is referred to in the essay; but I do not think I have any very fixed views on the subject. There was a time when I thought the Navy should take more control of the fixed defences, but I am bound to say it was just this: I considered that it might be possible for the Navy to take control of the fixed defences, that they would not exaggerate, and that they would take care that the money was spent in the most economical way possible for the defences, giving to fixed defences no more than was wanted, and giving to the movable defences all the rest; but I am bound to say, so much has the air cleared, and so far have we advanced towards accurate notions of how the Empire is to be defended, that I have changed a great deal, and I feel myself more ready to leave the fixed defence money in the hands of the Army. I see that all sides of the Army desire, and clearly desire, to understand the naval view and to work with it, and my belief is, that if the Army and Navy draw together thoroughly well, in the end we shall not dispute, and we shall not want to put fixed defences into the hands of the Navy.

Major BRIDGE: The points of discussion which have been raised by the two naval essays may be whittled down to this one question, a question which is exciting at the present moment national attention. This question really is, "Who ought to be responsible for the maritime defence of this Empire, including the defence of its naval bases and commercial ports?" In examining closely the arguments brought forward in both essays on this cardinal question, although there is a divergence of opinion, they almost arrive at the same conclusion, the prize essay stating that our military and naval forces should be under one Minister, and Lieutenant Hyde Smith's stating that our naval bases and commercial ports should be under the control of the Naval Administration. Now in the discussion of this subject, on which our very existence as a nation may depend, it is necessary that this subject be discussed without bias, and in the most impartial manner, and thus try to arrive at a solution which will carry us triumphantly through in the day of trial. To do this successfully all personal and selfish feelings must be set aside, vested interests must not be allowed to hamper or blind the mind, but whatever seems best and wisest for the national weal should be done. For the last fifty years or more, the

knowledge that England solely owes her predominating position among the nations of the earth to her maritime supremacy had been fading from the minds of the English people, but, fortunately, quite recently England has awoke to the fact that it is necessary to put her house in order; and as she is, *par excellence*, the naval nation of the world, the feeling that seems to be now growing in this country is, if we can judge by articles in the daily Press, in magazines, in pamphlets, and in the tone of discussions in this theatre, and in other places, that it is the birthright of the Admiralty to have control of everything in connection with the maritime defence of this Empire. And watching the increasing growth of this public feeling, and if one gauges it correctly, the general views in the prize essay seem to be vanishing, whilst the views on this subject which are expressed in Lieutenant Hyde Smith's essay, would seem to be the views fast gaining ground; and also it is presumed that they may be regarded as the views of the coming naval school, who in the natural course of events will soon be in a position to give them effect. Now, in the prize essay, to summarize shortly, the arguments advanced against the Admiralty having control of our naval bases are two. The first argument is, that if the Navy were intrusted with the control of our naval bases, the Navy would probably find itself forced to act on the defensive. The second argument advanced is virtually this, that the responsibility would be so great that the Navy could not cope with it. Are these arguments in accordance with the recognized canons of the art of war, that the control of the base and the advanced force should be in separate hands? Do these ideas represent the best traditions of the English Navy? Can it be supposed that such ideas were accepted by the naval heroes who have helped to make England what she is? By substituting the word Admiralty for Navy, I say designedly Admiralty, I hope I may be able to show you a way how to dispose of these arguments, and also how the Admiralty may be able to take up the duty of being alone responsible for the maritime defence of this great Empire. Now it is assumed that to garrison our maritime fortresses, coaling stations, &c., 40,000 troops are required: well then, let the War Office turn over these 40,000 troops bodily (artillery, infantry, engineers, &c.), with their Officers to the Admiralty, placing at their head some distinguished soldier, who would have a seat at the Board of Admiralty. Now, if this plan were carried out, you would virtually have what is so strongly recommended in both essays, and also you would do away with what nearly all home and foreign critics of our national defences condemn so strongly. By the plan I have mentioned you would have—1st, the whole maritime defence of this Empire would be under one Minister; 2nd, dual control in maritime defence would actually be at an end; 3rd, all naval bases would be probably armed with guns, gun carriages, &c., of naval pattern, and the troops who garrisoned these would be instructed in naval gun drill. All this would be of great importance, as ships-of-war have only a limited carrying capacity, and after any naval action, it is only reasonable to suppose that guns would be disabled, ammunition, &c., would be required, casualties would have to be filled up. Now if Malta, Hong Kong, Halifax, &c., &c., were under the Admiralty control, all these requisites would be at hand, and our ships-of-war having these means at their disposal in distant waters, might prevent at a critical moment a national disaster. Now in both essays the Marines have been mentioned in a very handsome way, Lieutenant Hyde Smith especially drawing out a scheme for their employment, a scheme which will meet with wide satisfaction. In the prize essay the author says that Marines are perfectly competent to perform any duty they may be called on to do, and that they would make excellent garrisons; but in the same breath, for what seems an untenable reason, he relegates them to a lot of small stations, where they would have the same position and status as the Marines at Ascension now have. Although the author may seem to speak on this point *ex cathedrâ*, and to be more conversant with the wants, aims, and views of the Marines, who are about one-fourth the fighting strength of the naval forces of this country, than any Marine could be supposed to be, it is only natural to think that if this scheme should be carried out, it might prove injurious to the Marines, and prejudicial to Imperial interests, for the places mentioned in the prize essay are only smaller links in that chain of posts which the foresight and wisdom of our forefathers gained for England, as bases for our Royal and Mercantile Navies. In the prize

essay a place has been assigned to the Marines in the defence of this Empire where Marines will have to share all the toils, hardships, privations, &c., incidental to all other defenders of this Empire; in justice then might not a place be assigned where they might hope to gain the highest rewards and recompenses that a grateful country has in her power to bestow on those of her sons who acquit themselves well in responsible positions in days of trial and danger? The proudest boast of the Marines is that they are an integral portion of the Navy; they are sister Services, but the *rôle* of Cinderella is not a *rôle* that many care to play.[1]

Mr. LAIRD CLOWES: It appears to me that we shall never properly understand the problem of the maritime defence of Great Britain, unless we insist upon regarding it as our ancestors regarded it. What was their view? They arrogated to themselves the proud dominion of the narrow seas. From a very early period, they considered that the sea, right up to the coasts of France and Holland—for there was then, I suppose, no three-mile limit—formed part of the patrimony of the King of England: and they consistently enforced that claim, by making foreigners in those waters strike their flags and lower their topsails. Now we do not want to re-establish "the honour of the flag"; but, on the other hand, we do not want to abate one jot of the substantial part of our claim to the dominion of the narrow seas. Unless those seas be in our hands, our position is endangered, and if they be in our hands, it is our manifest duty to protect the furthest borders of them. We are a sea Power, and our territorial boundaries are set, not where our cliffs fall into somebody else's waves, but where the other fellow's mud flats discolour our waves. In peace-time we don't interfere much with trespassers; but in war-time we shall, I suspect, be very rightly jealous of violations of our domains by improper persons; and if we have an enlightened administration, all its efforts will be focussed upon the great business of preserving a real sway over the narrow seas, right up to the enemy's territorial limits. That, I take it, will be the general plan of the next naval war—so far as Great Britain itself is concerned. The object will, I admit, be very difficult to attain; but, unless we move on those lines, we shall surrender half the natural and acquired advantages that we possess. Accepting this view, we find that the problem before us cannot be solved by the erection of great fortresses on our shores; for our shores constitute only the centre or "keep" of our Empire. What we need is defences on the very limits of our borders, defences which shall prevent the enemy from violating even the outskirts of our dominions. Land defences are for us a last resource: and recurrence to them implies that we are already upon the point of collapse. Offensive defence is the only kind of defence that would be willingly contemplated by a strong Power; and that kind of defence must be made upon the borders and not in the heart of the realm. I agree, however, that when we have done all that needs doing at sea, we may prudently turn our attention to the improvement of our land defences. All this leads up to considerations of a more practical kind. How are we to prevent infractions of our maritime territory? The obvious answer is: "By having a strong Navy"; and that is a very good answer, but it is not a sufficient one. As was pointed out here on Wednesday last, during the discussion on my lecture, we may expect that at the very beginning of hostilities, the enemy will attempt to send out torpedo-flotillas, which will not merely trespass on our territory at sea, but will endeavour to raid our great ports and destroy the ships in them. The possession of a strong, an overwhelmingly strong, Navy will never in itself render impossible this kind of thing. First of all, you cannot hope to effectively blockade all the enemy's ports within a few hours of the outbreak of war, even if you have a fleet ten times as large as you have now. Secondly, you may watch a port with a fleet as carefully as you like, but something will be sure to escape you. What we really want, then, to supplement the strong Navy is something which shall be more mobile than a fleet of battle-ships and cruisers; and which, nevertheless, shall do at least some of the duty of such a fleet, until the fleet can be sent to the spot. We want also something which, besides being quicker of application than a fleet, shall, even when the fleet arrives, assist it,

[1] It ought to be understood that the Marines have no dislike of garrisoning distant stations, but, if they do so, these Marine garrisons should start on a proper basis, and some good stations ought to be included.

if necessary, in more effectually preventing the invasion by the enemy of our maritime territory. Now I venture to think that we can find what we need in a class of very fast vessels of a type that is at present unrepresented in our Service: I mean 23- or 24-knot ships, kept ready for instant service, and so fitted that they may at once proceed off an enemy's ports, and there simply sow the water with mines. That, I think, ought to be our first object upon the outbreak of war, namely, to keep the enemy from coming out in any form, until we are ready to meet and beat him. To attain this we should have ships prepared to go and drop overboard large numbers of mines very rapidly. Of course mines will not seal up a place for long: but they will seal it up until our fleets can get before it; and, when the fleet is there, the enemy will, I suspect, be more welcome out than in. I venture to think that the designing of a fast and large craft for this special object deserves the attentive consideration of naval architects and torpedo Officers.

General Sir W. JERVOIS: Bearing in mind the observations made by Admiral Long that any discussions here or any opinions that would require a change of organization are not likely to be attended to by the British public, especially on the eve of a general election, I think it better, considering the views I have before expressed in this Institution, not to trouble you with any remarks.

The CHAIRMAN (Admiral Sir VESEY HAMILTON): Ladies and gentlemen, as Chairman I have a few remarks to make, and I will begin by saying that we all of us appreciate very much the labours of the two writers of these essays, which do them every credit, although there are points on which we disagree with them. I agree thoroughly with Admiral Salmon when he points out the deficiency of men to take over the submarine mines. Years ago, when that subject was first mooted, my opinion was that our taking over the submarine mines was out of the question, for the simple reason that, in the event of war, every seaman we can obtain is required on our naval frontier, that is, on the enemy's coast line. The men could not be there employed in active offence if they are employed in laying down submarine mines, a passive defence most unlikely to be attacked. Although perhaps we might do it better than the Royal Engineers, still they have done it sufficiently well. There is another point to which our attention has been called, and I am sorry that Colonel Moody and Major Bridge have gone, that is, to the Marines garrisoning certain ports. As has been pointed out by Sir Nowell Salmon, the Governor is Commander-in-Chief of the military forces, and if the Marines are placed in garrison in lieu of troops, is the Governor going to allow those men to leave the garrison if an emergency arises? We all look out for our own duty first; I therefore would deprecate strongly anything in the shape of a bone of contention between the Governor and the Admiral, which would be the case if they had co-ordinate authority over the Marines. The Admiral's work at sea, diplomatic and political, is sufficiently important to occupy the whole of his thoughts and attention. With regard to the Falkland Islands, I agree with Commander Sulivan. It is, as he says, the only piece of British territory from Sierra Leone round to the Canadian and Pacific coasts, the only piece of British territory at which we could make a naval station between Ascension and British Columbia. The intention of the Government is eventually to alter the commands, and to place South America under one Admiral on both sides: so that the Falkland Islands would be in the centre of his station, and he would have no great distance to go on either side; whereas at present his base is at Vancouver, which is too far off. That is the real reason for it. At the present moment all our warlike stores and ammunition are on an old wooden frigate in the neutral port of Coquimbo, a most inconvenient arrangement. Major Clarke remarked on the great expenditure involved in the proposals in the prize essay. Of course we all feel it is so, and it comes to this, are we going to lock up in 21 home stations and 41 foreign 175 torpedo-boats, forgetting the old adage that "Unity is strength, and dispersion is weakness"? You can only afford to disperse your force in the presence of a defeated foe. There is another favourite phrase, "Steam has bridged the Channel," which, in conjunction with "our fleets decoyed away," has cost the country millions of money, and the writer of the prize essay appears to me, as many others have done, to have misapplied it. It has done so for the stronger, not the weaker, maritime Power. I

should like to supplement the remarks that have been made on the subject of invasion. Admiral Colomb has pointed out in his work on "Naval Warfare" that Prince Metternich asked Napoleon in 1810 if he seriously contemplated the invasion of England in 1805, and whether the Boulogne army was not really meant for the Continent. Napoleon replied: "You are right. Never would I have been such a fool as to make a descent upon England unless indeed a revolution had taken place there." It must further be remembered that the Directory in 1797 offered him a force of 270,000 men to invade England. Napoleon went thoroughly into the matter, and, after visiting many seaports and collecting evidence, came back and made this report: "It is too doubtful a chance; I will not hazard on such a throw the fate of France." In 1805 the chances were still less in his favour, and I ascertained when at the Admiralty, from documents drawn out by the late Mr. Primrose, whose untimely death is a great loss, that at that time we could have concentrated in the Channel 60 ships of the line, 16 smaller line-of-battle ships, and 50 gun-ships, and over 120 frigates and sloops, besides gunboats; forces very far greater than the 70 ships of the line that Napoleon said would be necessary to obtain command of the Channel.[1] That is a fact, and Captain Mahan has shown in his work that historians are frequently at sea when they are discussing naval matters, and "their influence on history." There is another curious thing I came across the other day. In the old Saxon Chronicles we read that King Offa, in 755, protected this country against Charlemagne by his fleet, leaving to his successors this useful lesson, "He who will be secure on land must be supreme at sea"; so that this is no new doctrine. We go back to Saxon days, and perhaps to the Ancient Briton. "His successors neglected the Navy, and sought only to fortify their cities, a fatal mistake, for by thus permitting the enemy to land without interruption, small bodies of Danes, whom they might easily have cut off in detail, united themselves into irresistible armies." We come to the whole pith of the subject in the Saxon Chronicles of the 8th century. Another point that the essayist has altogether overlooked is the scarcity of Officers. In looking over the Navy List I find that in the Russian War, 1854-56, including Lieutenants, Mates, Masters, and Second Masters, we had 1,225 Officers employed out of a total of 1,842. At the present moment we have 1,108 Lieutenants, Sub-Lieutenants, Staff Captain Commanders, and Navigating Lieutenants, of whom 1,054 are employed, leaving a reserve of 54, totally insufficient for the wants of this great commercial country, even in peace-time, let alone in war-time. It must, moreover, be remembered that in that war we were in alliance with France, which you may say added one-third to our naval force, so that in reality we should have required 1,600 Officers at that time had we been at war single-handed with Russia, and that only for fighting purposes, for our commerce was never molested on the high seas during the whole of that war, which we can hardly expect in the future. At that time in the Russian War we had 77,000 British sailors and marines, and probably 33,000 French allies; we have now 74,000 men. It is extraordinary in the beginning of wars how rapidly our naval scale of men runs up. It is not generally known, I think, either by historians or by statesmen, that several years previous to the Russian War our annual force was 39,000, and we ran up to 77,000 in the two years war. In 1755, at the beginning of the Seven Years War, we had in commission 23 line-of-battle ships, 57 frigates, and 12,000 seamen. In 1756 we had increased our force in commission line-of-battle ships to 88 and our frigates to 110, and the seamen and marines were increased to 50,000. In 1760, four years afterwards, we had 115 line-of-battle ships, 186 frigates, and a naval force of 70,000 seamen and marines. Then we come to the war with our North American Colonies in 1775, when we had 18,000 seamen and marines and 31 line-of-battle ships and 71 frigates in commission. In 1780 we had 110 line-of-battle ships, 254

[1] Since this discussion I find in Bourrienne's "Memoirs of Napoleon," chapters 33 and 36, he never intended to invade England. His threats were to divert "attention from the real motive of his hostile preparation, which was to invade Germany and repulse the Russian troops which had begun their march towards Austria. Such was the true object of Napoleon's last journey to Boulogne," vol. 2, p. 337.

frigates, and 85,000 men; while in 1783 we had 110,000 seamen and marines and over 400 men-of-war in commission, and yet were overmatched by France, Spain, and Holland. Those increases are very startling. In those days, when a seaman went on board ship he very soon learned the simple gunnery. Now we must have trained men; you cannot do without them. At that time we had 110,000 seamen. I do not know what size the Army was: probably three or four times as great, and this out of a population of only 10 or 12 millions. In the Revolutionary War we commenced with 16,000 men and left off with 145,000, besides over 100 hired vessels, and we issued during those 20 years 10,000 letters of marque, so that we had an immense force of privateers as well. In fact, the naval force was almost incalculable, and yet we sustained a loss of 200,000,000*l.* of property by capture on the seas. There is one point on which I must very strongly differ, that is, where the essayist proposed to put our local naval defence under the order of Generals. In what I am saying I hope no one will accuse me of disrespect to the Army, but I should at once give a decided opinion upon that as most highly inexpedient. In 1885, when I was employed in organizing the defences round the coast, I was told on high authority that it was intended to place the local naval forces at each port under the orders of a General. My answer was, "You do not mean to say the Admiralty are going to stultify themselves in this way, that if an enemy attacks Holyhead, where we have no force, you are not going instantly to telegraph to the senior naval Officer in the Bristol Channel and at Liverpool (where local naval forces were to have been stationed) to concentrate upon the enemy." One General is responsible for Liverpool, and he won't let that force go; another is responsible for the Bristol Channel, and he won't let that force go; and the result would be that there would be a correspondence between the War Office and the Admiralty and the Generals, and by the time that was over, Holyhead would have been destroyed and the enemy escaped. In such a case the strong naval Officer would snap his fingers at the General, and the weak one would shelter himself under the General's orders. We cannot too strongly resist any attempt to place the Navy on its own element under the orders of the military, and as the military would do if it was proposed to place those on shore under the Navy; we never have been, and I hope we never may be. The British Navy has never yet been under the command of any foreign Officer, except on one lamentable occasion, when the French Navy being under the General, the General forced the Navy to attack Sebastopol; we were obliged to follow in the tail of the French, and a pretty mess we made of it. Sir Lothian Nicholson, who had been in the Crimea, was of another way of thinking on that point. I said, "Which Navy rendered the greatest service to the Army in the Crimea?" Beyond all doubt," he said, "the British." I replied, "Yes, you got from a hearty co-operation, what you would never have got from a sullen obedience to those we do not consider competent to command us." With regard to all these little petty attacks of our enemies, how are they to get to the places named? At the present moment there is not a French vessel that can get out to Tonkin or a Russian vessel that can get out to Vladivostock without the English coaling stations. Lay an embargo on issues of coal, and you would effectually stop them. Major Bridge suggests that 40,000 men should be turned over from the Army to the Navy with a General Commanding, who should have a seat at the Board. Speaking for myself, I strongly object to a mayor of the palace, as he would be on military matters. The Board of Admiralty is the responsible board for naval operations, and I think the Army should have no voice in it. I will wind up by quoting from an excellent article in the "Quarterly Review" of April last: "The only cheap Navy that England can have is one sufficient to defend her."

Friday, May 20, 1892.

MAJOR-GENERAL LORD METHUEN, C.B., C.M.G., Commanding Home District, in the Chair.

THE LATE WAR GAME IN THE OPEN.

By Major E. SATTERTHWAITE, 2nd V.B. the Queen's Own (Royal West Kent Regiment).

TOWARDS the end of February there assembled at the village of Ockley, near Leith Hill, a party of 38 Officers, members of the Home District Tactical and War Game Society. The party consisted of 9 Regulars, 5 Militiamen, 1 Yeoman, and 23 Volunteers, and among them were represented almost all branches of the Service—Regular cavalry, artillery, engineers, and infantry, Yeomanry cavalry, and Volunteer artillery and infantry; among them, also, were Officers who had made a special study of signalling, machine-guns, mounted infantry, cyclists, and transport.

The object of the assemblage was a somewhat novel one in this country, the practice of a continuous series of tactical exercises or war games in the open country. Various methods of acquiring tactical knowledge in peace-time have been practised—manœuvring with troops, war games on the map, the study of campaigns from books and lectures, and to these must be added the war game in the open. Until lately the practice of such exercises has been confined to military educational centres and to isolated days' work initiated by the various tactical associations.

While the object of the instruction was chiefly tactical, the director of the exercise, Lieutenant-Colonel W. W. M. Smith, R.A., D.A.A.G. for Instruction, Home District, was anxious incidentally to make the excursion more or less an object-lesson in the strategy best calculated to repel an invader; and it would seem desirable to reproduce his views on the subject, which are as follows:—

"The country we operated in was tolerably typical of the main lines of advance of an invader on London from the south. We were within sight of the more open country, both of the North and of the South Downs, and in between them lay the habitual closely-intersected country of the south of England; the larger area gently undulating, but lifted up into huge relief in one corner by the big features of Leith Hill.

"I can only conceive in general terms of, at the outside, three

alternative strategics, which can be looked on as at all efficient in our country; because the pure defensive, in even the very best positions, I regard as absurd if not ruinous; and, indeed, the purely defensive occupation of positions, assisted by the local small-scale counter-attack, is only one shade better.

"We are therefore restricted to the following:—

"(i.) To occupy carefully-selected defensive positions, situated so as to cover important strategic points where such exist, and to wait the attack of the enemy in case he is kind enough to run his head against our brick wall. To do this to any purpose involves the use of the counter-attack on the largest possible scale (*à la* Von der Golz), and is an operation most difficult to execute practically.

"(ii.) To use a position of similar type as a pivot for offensive operations on a large scale directed against the enemy's flank whenever he shall have committed himself to an advance beyond the rayon of the position.

"(iii.) The offensive pure and simple, *i.e.*, to seek him out under conditions in which you are nearly certain to fall on some larger or smaller detachment of his in greatly superior numbers.

"Now, with reference to these alternative principles of actions: the first presupposes a certain amount of complaisance, not to say fatuity, on the part of the enemy in falling into your plans; and even if he does, the smallest error in designing your big counter-attack, or some unforeseen obstacle may entirely upset your calculations.

"The second scheme is not a radically unsound one, as I think we successfully made out in our march from Holmwood to the Brighton-Reigate roads. At the same time it presents its chances of failure; and these chances are considerable when the cross-roads are few, tortuous, and in bad condition. Unfortunately, the cross-roads within a rayon of 50 miles round London usually are defective in these very points. Hence there is a great deal to be said in favour of taking up a defensive position no further south than the North Downs; since the surface of the great chalk ridge presents very superior lateral communications over which we could move large forces to fall on the flank of a too rash enemy. This, however, involves a large and, I think, unnecessary delay, and exposes a large territory to the enemy's depredations.

"Hence I think we may infer from our experiments, and that not very indirectly, that the third course is the proper one to take. The enemy's dissemination to east and west in the northward advance of, say, two or three army corps must, under existing conditions, be much wider than is usually supposed, if all his impedimenta are taken into account. That is, his battle-frontage while actually advancing through Sussex must be an excessive one for the purposes of meeting a determined attack, and the difficulties of intercommunication between his several columns on separate roads must be much increased by the close nature of the country.

"Hence I advocate going for him in greatly superior strength on some one or two lines of my own selection, having nearly a certainty, if my subsidiary operations are well designed and worked out, of

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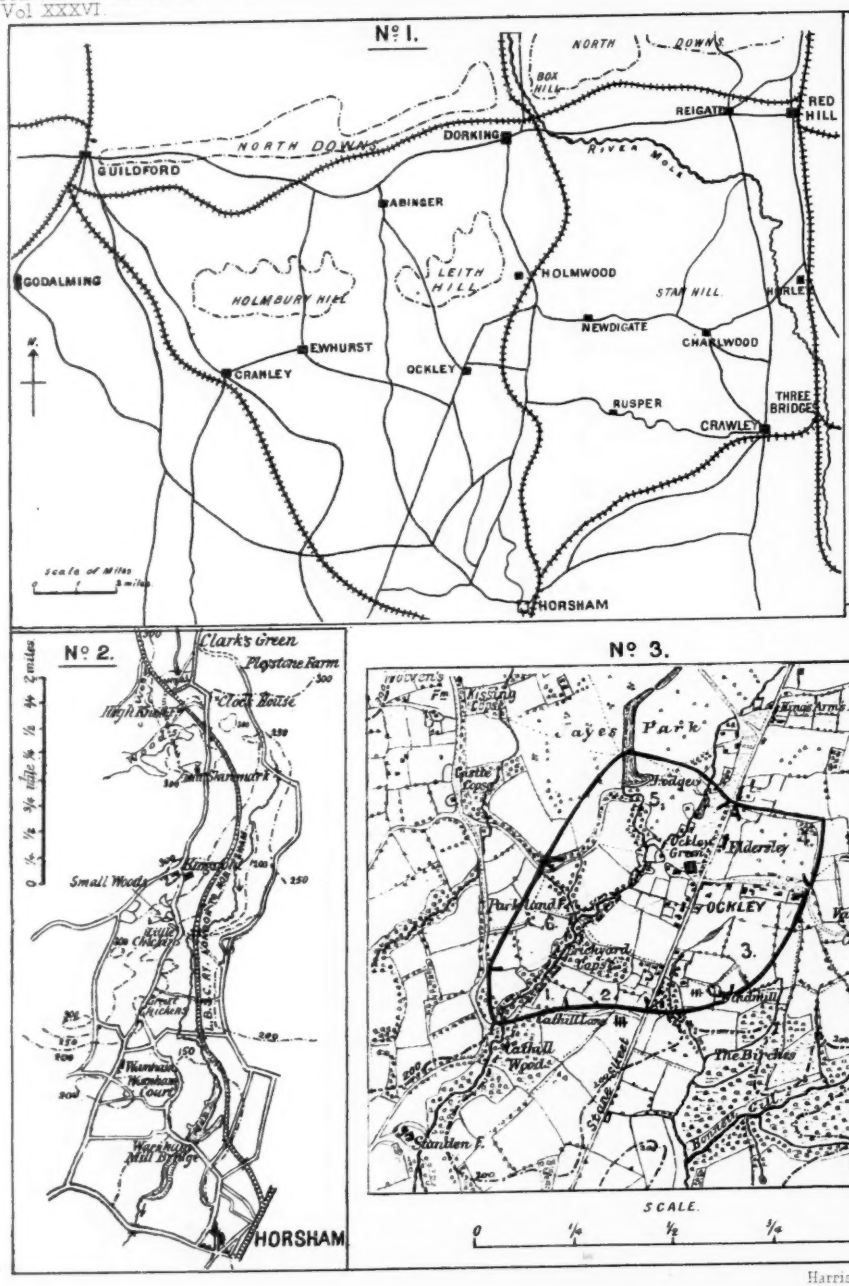

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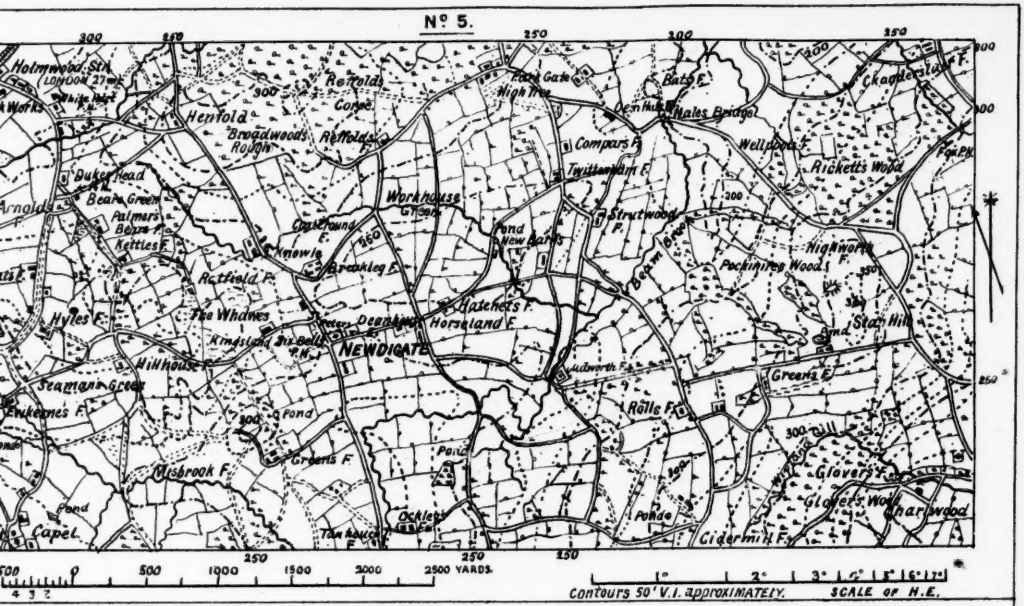

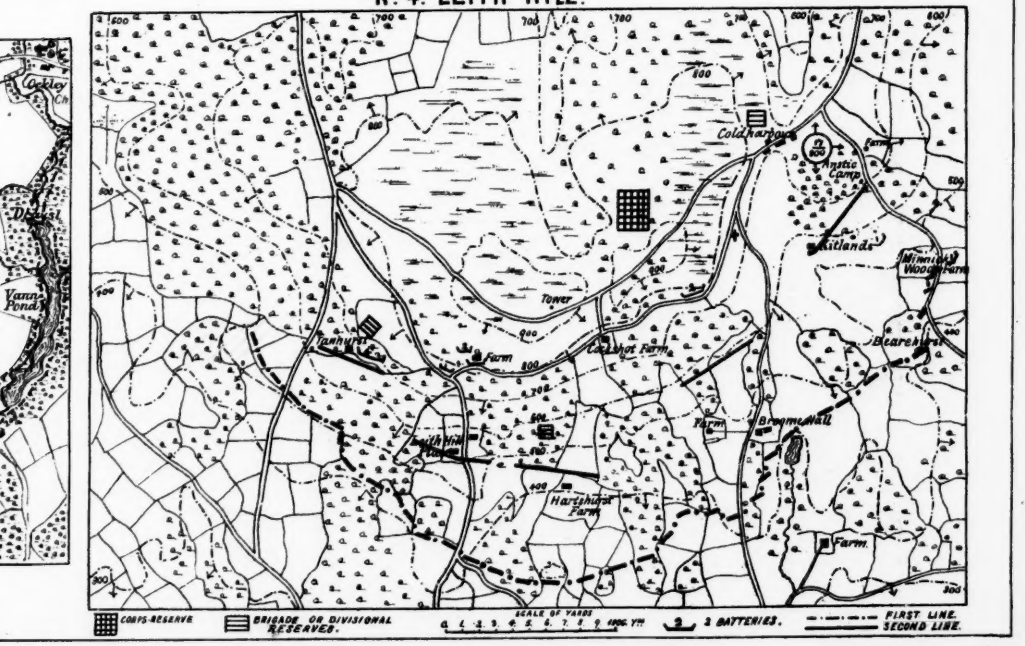

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inflicting a decisive defeat on some one or two of his advancing columns. I hold it as incontestable that such a check must bring his whole advance everywhere to a standstill or to a retreat.

"Then the question arises, Does the rapidity of our mobilization give grounds for hope that we could collect our forces in sufficient time to strike that blow before he reaches the foot of the North Downs? If you measure the time he must take to prepare for his invasion, to cross the Channel, to seize unguarded spots and then to disembark stores and men enough to enable him to move: add to this the actual time spent in marching northwards delayed by small parties, and you will agree with me that the time should be ample.

"Consider in connection with this our first day's operations: the country, in the number, the convergency, and the merit of the roads, was highly advantageous to the enemy's advance. No one can question but that the small force I operated with could have reduced his 15 miles march to one of 5 miles or even less. I cannot pursue the subject further for want of time, but I think the moral is easily drawn:—

"1. Delay tactics should be constantly studied and rehearsed on actual ground and in the war game in England, and with the very slenderest forces. The 'pioneer' movement must be developed to the utmost, and especially by the mounted services.

"2. The tactical and moral attitude of the strategic offensive and of the actual attack must be inculcated in season and out of season, and incessantly practised.

"3. Bad marching on the part of any battalion must be considered a crime.

"4. Advanced guard distances in our own country must be somewhat reduced.

"5. Above all, the enemy must never be allowed to grasp either the strategic or the tactical initiative even for a single moment, and least of all in the 'combat de rencontre.'"

Tactically the four days' operations were based on one general idea, and with a view to eliciting criticism on the past and suggestions for future work, I propose to give a short description of each day's work and its method of execution.

The scheme for each day was printed by the Society, as also a seniority list of the Officers; on the evening before each day's work, a copy of the scheme was issued to all concerned with one of the lists, each Officer's task being marked opposite his name, and a complete list of Officers and their duties posted at the headquarters of the expedition, the Red Lion, Ockley.

The general idea was as follows:—

HOME DISTRICT TACTICAL AND WAR GAME SOCIETY.

Scheme of Operations for Tactical Exercises in the Open Air for February, 1892.

GENERAL IDEA, *v.* PLAN 1.

The Invader has landed in considerable force on the Brighton—Shoreham Coast, has surprised the Shoreham Fort, and is engaged in disembarking Stores and Supplies in the Shoreham Basin.

He is at the same time advancing in force towards the North Downs by several roads. Whether Guildford, Dorking, or Reigate is his immediate objective is not as yet apparent. He appears to have in front of every column a vigorous, though not a numerous cavalry.

Another considerable force (probably 1½ Army Corps), which has effected a landing at Rye and Hastings, is pushing (apparently) on Sevenoaks; and its advanced parties have just seized Tunbridge Wells.

The British Army is assembling behind the North Downs between the rivers Wey and Medway, so as to cover London.

The special idea issued on the night of the 25th for the work of February 26th was as follows: the subject of the day's Tactical Instruction being the "Rear Guard."

SPECIAL IDEA; *v.* PLAN 2.

February 26th.

Rendezvous, HORSHAM STATION, 9.50 a.m.

The Enemy appears to be advancing on a broad front and by every available road.

The Advanced Guard of one column occupies part of Horsham by nightfall on the 25th, with his advanced posts, the Northern outskirts of the Town being still held by the Rear Guard of British troops withdrawing on Dorking.

From

THE LIEUT.-GENERAL,
Commanding 1st Army Corps assembling on Leith Hill.

To

BRIG.-GENERAL A——.
Commanding Rear Guard on Horsham—Dorking Road.

Corps Headquarters, ABINGER,
3 p.m., 25th February, 1892.

There appears little doubt but that you have in your front a whole Corps of the Enemy, headed by a Brigade of Cavalry.

It is my intention to maintain the Leith Hill position at any cost, pending the arrival of the 2nd Army Corps, expected to arrive in line before daybreak on the 2nd March.

Should the Enemy in your front resume his advance to-morrow, you will continue to withdraw in the direction of Dorking, delaying him stiffly, but not in such manner as to expose your force to demoralization.

I have directed Col. B—— on your right to withdraw along the Roman Road on Ockley, which is held strongly. His left is demarcated from your right by the line Slinfold—Strood Green—and thence by the North Brook.

On the other flank Col. C—— has been directed to hold all the lanes Eastwards of the Horsham—Dorking Railway, as far North as the Clock-House, crossing at which point you will yourself become responsible for all avenues within a mile E. of the Horsham—Dorking main road.

A squadron of Cavalry, a Company of Mounted Infantry, and 6 Guns, will be placed at your disposal by 7 a.m. to-morrow; also a Company of 30 Cyclist Infantry.

Orders by BRIG.-GENERAL A——.

7 p.m., 25th February, 1892.

The latest information leads me to anticipate that the enemy is unlikely to press his advance before noon to-morrow. Major D—— will assume charge of the whole of the delay operations between the North Brook and the Broadbridge—Warnham Road. I shall myself march at the rear of the main body of the column retiring by the direct Horsham—Capel Road. Lieut.-Colonel Smith, with the Officers of the H.D.T.S. at his disposal, will make a preliminary reconnaissance of this route,

starting at daybreak, and reporting his recommendations to me as early as possible.

The following will be the guiding principle of the day's operations. Every road or possible avenue of hostile advance to have its appropriate group. Deployments for delay will (in default of orders from Commanders on the several roads) conform as far as possible to those of the contiguous groups on either flank, but be otherwise independent. All independent action to cease at once, whenever superior orders can be obtained.

It will be seen that successive positions had to be reconnoitred for occupation by the following troops in a rear-guard fight:—

1 squadron of cavalry.
1 company of mounted infantry.
1 company (30) cyclist infantry.
1 battery of artillery.
1 brigade of infantry with two machine-guns.

Accordingly, on the 26th of February, the party of 29 Officers assembled at Horsham station at 9.50 A.M., and immediately moved to the outskirts of the town.

After impressing on the Officers the necessity of studying conciseness in explaining their dispositions, and laying down the principle that it was not intended to make a running fight along the whole road, but to make a determined stand about every three miles, Lieut.-Colonel Smith led the party to first rendezvous.

For each of the three proposed positions an Officer was detailed to report on each side of the road for occupation by about half a battalion; to him an assistant was appointed whose duty was to design the line and method of retreat, while to each position was assigned an Officer to choose positions for guns and machine-guns.

The first position was in rear of Warnham Pond, the second at Kingsfold, and the third at Clock-house, while an Officer (mounted) was appointed to ride to a possible fourth position at Beare Green, and report on it as a defensive position, and also a possible camping ground for the whole rear guard.

In addition to these tasks, Officers were appointed—

To arrange the order of march between positions and to draft orders in accordance.

To consider the action of mobile troops in minor delay operations between positions.

To consider the alternative of offensive action.

To consider the action of the detachment on the Warnham Road, and lastly, two Officers were appointed to consider the action of the enemy's advanced guard.

The whole party having assembled at Warnham Pond, the Officers detailed for the first position explained the proposals for their section of the defence, and took the party over the actual ground they proposed to occupy.

The dispositions were criticized by Lieutenant-Colonel Smith, and then the enemy was invited to explain his proposals for attack. He had at hand only one brigade of cavalry, his infantry advanced guard not having as yet come up. Sending one regiment to the north and west

of Horsham, he pushed his other two regiments along the railway, and so on to the left flank of the defence. The nature of the country to be traversed by this force and the amount of exposure they would be liable to were fully discussed.

The delay to the enemy at this position was calculated. Proceeding to the second position at Kingsfold, the Officers charged with designing its defence explained their proposals in a similar manner, and the whole went over the ground.

It transpired that the enemy, finding his infantry coming up, and the country very much exposed on the east of the road, had changed his line of advance near Warnham to the western side, and intended to press an infantry attack on the right or western flank of the defence.

Lunch had been sent out to this point, and during its consumption the mist, which had hitherto covered the country, lifted, and a glorious afternoon ensued.

The third position at the Clock-house afforded the enemy a perfectly screened advance up to the right flank of the defence. Placing his guns on the foremost of two hills, close to the main road, he diverted his infantry to the west. Thence, screened by the woods and wooded lanes, he would have gained and turned the defenders' right flank. Before separating for the night the officers charged with reporting on the various staff duties mentioned above gave their opinions, which were criticized by Lieutenant-Colonel Smith.

The special idea for the next day with an outline of the various Officers' tasks was then issued; the task being "The defence of a village as a supporting point in a line of preliminary resistance."

SPECIAL IDEA; *v.* PLAN 3.

27th February.

Rendezvous, "RED LION," OCKLEY, 10.15 a.m.

Orders by D.A.G. to Brigadier-General A.

Headquarters: Abinger,
3 p.m. 26th February, 1892.

It is essential to gain time for the preparation of the Leith Hill position.

A preliminary advanced position has therefore been selected along the line, Lowerbreach and Pondhead Farms, Ockley Rectory, Clark's Green, which must be held at any cost till dark on the 27th.

You will hold with your Brigade the village of Ockley, converting it into a supporting point for the rest of the line, and blocking the Roman Road. Your frontal defence should embrace the south of Jayes Park on the west, and as much ground as you may find necessary for the maintenance of the village on the east. 2 Battalions of the N'th Brigade, a Battery, and half R.E. Company, will be at your disposal by 8 a.m. to-morrow, should you inform me by 6 a.m. that you require their services. Time probably available for working parties: from 3 to 6 hours from dawn.

The force employed was—

6 battalions of infantry with 2 machine-guns.
1 battery of artillery.
½ company R.E.

The Officers present numbered 29.

The 6 battalions were assigned sections of the defence of the village.

Three Volunteer battalions had sufficient Officers present to undertake one of these sections each, and 3 provisional battalions were formed, 1 of Militia and 2 of Volunteer Officers.

Officers were also assigned for the following duties:—

Guns and machine-guns.

Construction of field work near the Windmill.

Signalling arrangements.

Two Officers were also told off to represent the enemy, now increased to the strength of a full division.

Assembling at the Red Lion, Ockley, at 10.15 on a dull morning, the Officers were immediately taken to their positions and shown the extent of front their battalions had to occupy, and boundaries of their sections of the defence.

To No. 1 battalion was assigned the right front of the village, No. 2 prolonging to the Roman Road, for which it was held responsible.

No. 3 battalion had a difficult piece of country comprising the left front and part of the left flank.

No. 4 battalion completed the left flank and threw back on to the Roman Road by the Red Lion.

No. 5 battalion after completing the defence of the gorge of the village had 4 companies available for the protection of the right flank.

And between the left of this battalion and the right of No. 1 the space was filled by No. 6 battalion.

Battalion Commanders were ordered to send back to the Brigadier as a general reserve any companies not absolutely required for the defence of their sections.

The morning was devoted to the reconnaissance of the position, the midday rendezvous was at 1 P.M., and after lunch, the whole party started to make a tour of the village precincts.

Standing end-on to the enemy's advance and composed of small weakly-built houses, the village itself afforded few advantages for defence. At the same time the proximity of thick woods on the left and broken country in front and on the right flank, both of which would screen an enemy's advance, rendered it necessary to protect the position from attack on all sides.

Each Officer explained his proposals for the defence of his section in accordance with the time and means at his disposal, and these proposals were then and there discussed and criticized.

The following points among others claimed attention:—

The necessity of advancing the guns at first into the foremost fighting line, owing to the absence of positions on the flanks.

The avidity of Battalion Commanders to secure the two available machine-guns.

The completeness of the signalling arrangements, connecting with permanent and field wires to Leith Hill.

The construction of a four-hour blunted lunette at the windmill: its trace and profile being shown with tape.

The utilization of the lower brick-built floor of the windmill as a reduit to the work, and the possibility of the speedy destruction of the upper wooden part.

The enemy then explained his proposals for the attack of the whole advanced line.

His cavalry would reconnoitre at daybreak and discover the construction of the fieldwork near the windmill.

His division would then form for attack as follows:—

Right attack: 3 battalions, 2 machine-guns, and 1 battery against Clark's Green:

Centre attack: 1 battalion, 2 machine-guns, and 2 batteries against the south of the position, especially directing fire on the Rectory and fieldwork.

Left attack: 4 battalions firstly against Pondhead Farm; this taken, they were to move east and attack Ockley from the side of Jayes Park.

The right and left attacks were to be as far as possible delivered simultaneously.

The decision arrived at was that the defence would be able to hold its own against this attack, more especially as the left attacking force in its eastward movement would expose its left flank to the heavy artillery stationed on Leith Hill.

Orders for Monday's work were then distributed, and the party separated to meet later on at the guest night of the expedition at the Red Lion. It may incidentally be mentioned that the provision of suitable quarters for so many Officers strained to the utmost the capacity of the inn and lodging-house accommodation of the village: the country gentry, however, came to the rescue, and many Officers have cause to remember their hospitality.

Alike from them and from the farmers over whose land it was necessary to pass the greatest kindness was received: and this in spite of the fact that the country side was suffering from a bitter disappointment: it had pictured to itself the peaceful invasion of the district by all the pride, pomp, and circumstance of mimic war, bands, uniforms, and blank cartridge; and in their place it saw a commonplace mufti crowd, whose principal weapons were the note-book and shooting boot.

The third day's work was the most ambitious of the four, as the special idea will show, the preparation and occupation of a strong natural position being the subject of the exercise. Senior Officers of the Volunteer force are often called on theoretically to command as large a force as a division at the war game on the map: on this occasion some idea of the extent of front a division would occupy on the defence was seen in the open field with the advantage of having the boundaries already laid down.

SPECIAL IDEA; *v.* PLAN 4.

29th February, 1892.

Rendezvous, ANSTIE FARM, HOLMWOOD, 10 a.m.

The troops collected behind Leith Hill suffice for the occupation of only the Eastern moiety of the whole range. The Lieut.-General in command is instructed, at all costs, to hold his ground on the ridge till the morning of the 2nd March, and to dispose his troops so as to command the Abinger Gap on the West, and the Horsham—Dorking Road on the East.

Troops available:—1 Army Corps with 2 additional Infantry Brigades. Reinforcements may arrive by dusk on the 1st March, when it is proposed to take the offensive.

The Home District Tactical Society is placed at Lieut.-Colonel Smith's disposal to assist him in designing the defence of the central section of the line.

Troops available:—2 Divisions. He is held responsible for the ground from Leith Hill Place on the West (closing the Ockley-Parkhurst Road) to the line Anstie Farm—Bearehurst on the East. He will also reconnoitre the whole front, so as to accommodate the largest possible number of guns likely to prove effective to right and left, as well as directly ahead of his own alignment. Probable time available for working parties on the defences—4 to 6 hours. All spare troops not indispensable to the main line of the defence, as well as all details employed for previous delay-action, will be sent to strengthen the General Reserve in the hands of the Lieut.-General commanding the Corps.

Boundaries:—

II. DIVISION.—WEST.—Between Parkhurst and Leith Hill Place, 500 yards W. of the latter.
EAST.—Park Drive, W. of high road under Broom Hall leading to Residences of Mr. Cattley and others.

III. DIVISION.—WEST.—Ditto.
EAST.—Kitt or Sheepwash stream, E. of Bearehurst.

The Officers were distributed in the same way as before, to arrange the defence for the divisions, with their component brigades, battalions, and batteries. Their position will be seen on the diagram.

The midday rendezvous was on the heights above Coldharbour, at 1.30 P.M., and thence the party walked westward along the ridge as far as the right boundary, inspecting the proposed artillery positions as they went.

Descending and turning eastward, the infantry positions of each brigade were discussed and criticized in detail.

It was found that the Divisional Commanders were able to spare, in all, three battalions, which would be formed into a reserve brigade and placed with the remainder of the corps troops on the lateral road running behind the brow of the ridge.

The Officers representing the enemy reconnoitred the position from his point of view and selected Broome Hall as a possible objective for his attack.

Among many points of interest which arose during the day, the following may be noted:—

The difficulty of seeing the actual main roads even in winter and from a commanding elevation like Leith Hill.

The infantry first line of resistance had to be advanced far down the hill.

The policy of placing the artillery on the actual crest or on a lower level, where its fire would be less plunging.

The final day's work was based on the following special idea, the general outline of the instruction being the march to attack the flank of the enemy's advancing columns, and special attention being devoted to the details of the advanced guard movements:—

SPECIAL IDEA; *v.* PLAN 5.

1st March.

Rendezvous, HOLMWOOD STATION, 9.30 a.m.

Orders, 5 p.m., 29th February, 1892.
Army Headquarters, ABINGER.

There appears now no doubt that the Enemy has suspended his march on the Leith Hill position, and is endeavouring to slip round our left to effect a junction with his Eastern Army near Reigate.

It is my purpose to advance as rapidly as possible to-morrow on Horley and Three Bridges Stations, so as either to strike his line of advance, or seize his communications, as the case may be. Some resistance from his left flanking guard may be expected on the line of Stan Hill, between Charlwood and the Mole.

No. 1 Division will advance by Ockley and Rusper on Crawley.

No. 2 Division and Army Corps troops by Holmwood Station, Newdigate, and Charlwood on Horley. The Lieut.-General will be found at the rear of the Reserve of the Advanced Guard on this line, and will be near Newdigate by about 11 a.m.

Nos. 3 and 4 Divisions are placed for to-morrow under the command of General F——, and will march by such cross road as he may direct on the left of No. 2 Division, so as to seize the Norwood and Horse-Hills Road Junction.

It will be understood that the Advanced Guard commanders will act with prompt decision, and above all things prevent the march of the main columns from being arrested by small parties of the Enemy.

The formation and action of the centre column, composed of No. 2 Division and the corps troops, formed the day's task.

Officers were detailed to act as if in command of the following troops:—

Foremost cavalry group advancing along the road.
Supporting cavalry squadron.
Van Guard.
Main Guard.
Main body.
Artillery.

Officers were also detailed to keep up communications with the right and left columns, to reconnoitre the line of the Mole, to design a camp at Stanhill, to consider the utility of quick-moving infantry, cyclists, or mounted infantry in such an advance, and to calculate the length of the column and the time its units would take to come into action against Stanhill.

Officers were also detailed to consider the action of the enemy's flank guard.

Before leaving the rendezvous, Lieutenant-Colonel Smith laid down the principle of the day's advance—the active onslaught on to the

enemy's flank—and prescribed the strength and distances of the advanced guard; these distances, under the circumstances, being somewhat less than the normal formation.

They were as follows:—

Centre group of screen of Army Corps Squadrons.

Flankers. 600 yards. Flankers.

Remainder of Army Corps Squadron.

400—1,000 yards.

Van Guard:
- 1 troop divisional squadron.
- 1 section R.E.
- 2 companies infantry.
- 3 guns without wagons.
- 2 machine guns.
- Remainder R.E.
- 6 companies infantry.
- S.A.A. carts.
- Signallers.

400—800 yards.

Brigadier-General Commanding Advance Guard.

Main Guard:
- Cyclists.
- 3 guns.
- 1 pontoon section.
- Brigade pioneers.
- 3 battalions.
- S.A.A. carts.
- 3 wagons.
- ½ bearer company.
- ¼ telegraph battalion.

500—800 yards.

G.O.C. the division.
2 companies infantry.
2 divisional batteries.
Remainder of advanced guard wagons.
6 companies of infantry.
Corps artillery.
„ machine-guns.
„ battalion.
„ field company, R.E.
Brigade of infantry.
Signallers.
¼ telegraph battalion.
Remainder pontoon troop.
„ artillery wagons.

The length of the column would thus be about 6 miles, and would take about two hours to pass a single point.

On arrival at Newdigate it was found that the enemy had established there a small mobile force for delay purposes; its action and the attack were considered in detail.

On arival at Cudworth, an old moated grange, it was found that the old brick bridge had been destroyed and that the road beyond, though marked as a main road on the Ordnance map, was unmetalled, grass grown heavy clay, and utterly impassable for military wheeled traffic.

The advanced guard artillery was already committed to this road, but there was ample time to divert the bulk of the artillery by Park Gate and Hales Bridge, a fresh infantry escort being improvised.

As the advance was continued the dispositions of the enemy's flanking detachments (2 battalions) and the counter movements of the advanced guard were considered in detail.

Lunch was sent out to Stanhill, and the return journey was taken by the Hales Bridge route, when the artillery Commander explained his dispositions by the new route.

At 2.30 P.M. the day's work closed, the principal points of interest having been—

The detailed advance of a cavalry advanced guard.

The distances between the units of an advanced guard in an enclosed undulating country.

The action of small delay parties and the means of overcoming them.

The necessity for reconnaissances of country roads instead of relying on Ordnance maps.

The semi-independent action of the corps artillery on a separate road.

The hasty repair of a low brick bridge.

This concludes the narrative of the different days' work; enough has probably been said to show that each day's work afforded many opportunities for the study of more or less simple tactical problems.

The 1-inch Ordnance map only was used, as being the largest scale likely to be available on active service.

To Lieutenant-Colonel Smith the initiation of the expedition was due, and to the great pains which he took in the preliminary framing of the schemes, and in the conduct of the exercise on the ground, its success must be attributed.

To him and to the Officers who have kindly helped me with the diagrams for this paper my best thanks are due.

Some suggestions for the improvement of the details of working such a series of exercises were received on the ground, and this paper is read with a view to eliciting further suggestions to the same end.

Lieutenant-Colonel W. J. Alt (22nd Middlesex Rifle Volunteers): I am sure I express the feeling of every Officer who was present at Ockley, and also of every member of the Home District Tactical and War Game Society, when I say that we owe a debt of gratitude to Colonel Smith for the trouble he has taken in initiating this out-door work, and for the success with which it has, so far, been carried out, and also to Major Satterthwaite for so ably assisting him. There can be no doubt whatever of the great value of these out-door exercises. Whenever I take my walks or rides abroad I look at the country more or less from a military point of view; but there are others, perhaps, who look at the surroundings from a more sporting aspect. I am, therefore, of opinion, that one day in the open is of more value than a whole season of war games played on the map in Westminster Hall, and I hope

Colonel Smith will be able to continue these exercises in the future, when I am sure Major Satterthwaite will be always to the fore to second him. The work this year was, to my mind, so interesting and successful, that I can hardly offer any suggestions for its improvement in the future. One question arose with regard to the season in which the work should be carried out. The weather had been very severe the week previous, and continued very threatening at times, and it is worth consideration whether it might not take place later in the year, so as to ensure better weather and longer days. It will not be surprising, in view of the part I have taken in introducing the use of machine-guns into the Army, if I say I am pleased to find the lecturer has recorded the avidity with which the battalion commanders wished to avail themselves of those weapons. You, yourself, my lord, know the use we have made of these guns with former Easter marching columns under your command, and I am of opinion that an enclosed country like England, with its accentuated features and narrow lanes, affords most frequent opportunities for the use of those weapons, and from many years' experience in working over the country between London and the Channel coast, I find nearly the whole of the south of England is more or less admirably calculated for delay actions by rear guards. You can hardly traverse 10 miles of country without finding successive positions in which an enemy's march might be checked, and where machine-guns would prove more handy and effective than artillery. The lecturer has pointed out another thing which was demonstrated, viz., the difficulty from even a dominating height, like Leith Hill, of detecting the main roads of approach, and Colonel Smith will, no doubt, tell us how difficult it was for the attacking artillery to find points from which they could bring our positions under fire. The ground was carefully studied and measured, and there were very few positions in which the enemy could bring more than one, or at most two, batteries into action against our position. The same thing was found to be more or less the case on each day's work. I again express the hope that these exercises will be continued, and that more Officers will be able to take part in them; for I look upon the work as the commencement of a new era in the study of war in this country.

Lieutenant-Colonel W. W. Smith, D.A.A.G.: I am glad that one hiatus in Major Satterthwaite's interesting and able paper has been already in part supplied by Colonel Alt. Major Satterthwaite, with his well-known modesty, has omitted to say anything about his own work on the occasion of our out-door exercises. Speaking for myself, I do not think I could have attempted the exercise at all, so far as my humble share in its prosecution extended, if I had not had Major Satterthwaite as a Quartermaster-General to make all the administrative arrangements for me. Many of you will hardly realize the very great amount of trouble and forethought it must have cost Major Satterthwaite and his assistant, Captain Latter, though you may in part imagine it. I happen to know that at that very time Major Satterthwaite was extremely busy, not only with his ordinary professional work, but also in matters connected with his own battalion; yet he took this very great amount of extra labour upon his shoulders, and carried it through in a way which earned universal applause amongst those Officers whose comfort was affected by it in our excursion. There are just one or two points I would crave indulgence to speak about. In those few remarks of mine which Major Satterthwaite has embodied in his lecture, of course, I was only able, in very general and somewhat delicate terms, to advert to the important problem of the defence of London. One could not, for obvious reasons, go deeply into that. I am not sure whether, in my anxiety to advocate a sound strategy, I have not said more than I intended; but, at any rate, I had a very distinct object in view, and I wish once more to strengthen the same impression. It is this—that there is no more misleading, and, therefore, injurious expression than that which we so often hear nowadays—that the traditional and nationally appropriate method of British fighting is that of the defensive. I believe we shall never make very much progress in our arrangements for fighting in this country unless we adopt that principle of fighting which every Continental Power inculcates in and out of season on its troops, at any rate in theory. We cannot be too "aggressive" in intention and practice; and unless we train, arm, educate, and prepare ourselves in every way for winning our campaigns by a bold assumption of

the initiative in our strategy, and then, subsequently, by taking the tactical offensive as well, I feel sure we shall run a risk of coming off second best in any large struggles which we may have to conduct by land against European troops on otherwise equal terms. That is a point I feel very strongly about, and I only hope that the vastly superior efficacy of the offensive attitude has transpired a little, not only in my cursory comments in the field, but in the paper which has been read. One word as to the different methods of instruction that the lecturer alludes to. It seems to me that, perhaps, the most important practical question which is put in issue in the paper before us is this: What, after all, is the best method of teaching, not only civilians, but regulars, tactics in the field, getting so very few opportunities of actual field manœuvring as we do? Ours is a particularly cramped country, and the opportunities afforded for autumn manœuvres are, from one cause and another, indeed few and far between. We do not practise above one-tenth of the Officers in the country, and, even when they take place, we cannot take troops over enclosed and valuable ground. How then are we to learn our work? Of course, the best of all ways is by the actual handling of troops on varied ground; but that, after all, only gives instruction to a small number. The attention of the regimental Officers is almost entirely taken up with training the men, and compelling them to conform to orders; and there are only a few Senior and Staff Officers who have the privilege of applying the higher principles of tactics in manœuvring battalions and brigades and divisions in the field. Then, again, we have the old methods of text book reading. I am not sure that, in default of other methods of learning, we have not carried this, valuable though it is up to a certain point, almost too far. I, for one, have had a good experience of it. The number of text books I have had to read, with the view of educating myself, has been considerable; and I feel sure that in nearly all of them you find one general defect—you find the contingencies and the resources of tactical science arranged in interminable categories; and the head aches, while the memory rebels, when you attempt to recall one half of them. Imagine the possible position of an Officer who has been educated in text books alone. He arrives at the field of battle. Some unexpected emergency arises. He is worried by conflicting reports; and has too little time to hunt for a decision. He has to think to himself, "In what position do I stand? I was once taught how to conduct a flank march under conditions similar to these, and I was told there were five considerations that should induce me to take a certain course, and six considerations to lead me to avoid it. Let me see which of them is the most relevant at this particular moment. Does it come under head A or head C, or what other head?—I wish I could remember my memoria-technica for that list." You can imagine the sort of mental fog which would descend on that man's reasoning powers at the very outset of his operations. That, it seems to me, is the outcome, in somewhat exaggerated terms possibly, of what will happen with a man who is a student of text books—and of text books only. Then we have the method of learning by lectures. I admit that lectures are a very admirable means of imparting instruction; but after all they present it in a somewhat indigestible shape, simply because the information they contain is so extremely condensed, and because we have not to make sufficient intellectual effort in apprehending or weighing the conclusions they purport to arrive at. Therefore, they fail to a certain extent. Then there is the kriegsspiel. The war game, as played indoors, is admirable as regards the preliminary amount of real work which the competitor has to go through before he can devise a fitting scheme. There is hardly any other method by which an Officer can so fitly, in times of peace, have a definite strategic problem put before him. When he has thought that out, and carefully written out his orders, and more especially when the first move under fire has taken place, I am not sure that the main value of the exercise has not ceased, at any rate until the time for the final critique arrives. This, especially when made, as it usually is in this district, by our friend Colonel Hale, is, I admit, of the utmost value. But it must also be conceded that the chief value of the exercise, for the most part, terminates when you arrive at the initial moves of the pieces, particularly those which are supposed to take place under fire. Then, of course, there is the study of military history, which, within its known recognized limits, is invaluable. Last of all, we come down to this method, which, I think, we in this district may claim to have been the first to

originate, and which is now under discussion. I never heard, at any rate, of instruction being carried out on similar lines elsewhere. It seems to me that this method, taken as a whole, is the most valuable of all; and partly, I suppose, for this reason—that it stimulates our imaginative powers. I think we ought to get into the way, when we are travelling about the country for business or pleasure, of taking stock of its features from the soldier's point of view. Think, for instance, of the different travellers you meet with in an ordinary railway journey! It is not difficult to infer, from their conversation, their several points of view. One man, as he looks from the window, regards the country from a sporting standpoint; amusing himself with estimating how he would take the fences as he goes along. Another will look at it simply with reference to the fertility of the soil and the rotation of crops. A third looks at the nature of the sub-soil; the cuttings give him indications of the series of geological formations; while, perhaps, a fourth considers it merely from the artist's standpoint, and its capacities for picturesque effects. I think while we get all the elements of pleasure and profit we can out of these standpoints of view, we should habituate ourselves to work all these aspects into one of equal interest and more decided utility to our profession—the analysis, as it were, of country from the soldier's point of view, and I know no way which so generates and encourages this habit of mind—one (I would remind you) particularly recommended by Sir William Napier—as this sort of exercise. With reference to the relation of topography to military science generally, there are one or two traditional upas trees against which I should like to contribute my stroke of the axe, while I am about it. There are a vast number of Officers who think a soldier cannot possibly be made without his becoming first of all a first-rate draughtsman. I am not sure that some would not say becoming an artist. I have most painful recollections of day after day spent by myself in being taught the mere pedantry of what we used to call "worming;" endeavouring to represent the slopes of a hill by means of hachures. That time seems to me to have been worse than thrown away. It tended to create in my mind, if not a disgust with my profession, at any rate with the pedantry which our superiors of that day insisted on making a stepping-stone to its higher teaching. Of course we have better methods of representing hills now, but my point is this: that those Officers who have been told they cannot learn tactics and strategy and soldiering in the field, because they are not neat draughtsmen, may put that discouragement out of their heads altogether. In the work that we did in Surrey, we hardly called upon draughtsmanship at all, and, if at any time it appeared to individual Officers desirable to elucidate their dispositions by a hasty eye sketch, it was done with ease by Officers who, in most instances, had no pretension to be artists, or to have made any special study of topography. In fact, military science does not end with topography, and I am not sure that it necessarily begins with it: and, therefore, Officers who have not the opportunity of becoming polished draughtsmen need not be afraid of attacking more advanced problems of military science. As to the future development of our method, I am anxious that our little campaign at Ockley should be looked upon as the infancy, rather than as a fair specimen of what its maturity should be. I myself learned much by my experience as to efficient ways of conducting the different stages; and I am of opinion that the system is one which is capable of a wide development. It is certainly a much more pleasant and healthy way of acquiring military knowledge than those alternatives that I have briefly mentioned or discussed. In addition, I think we could make it very much more like the war game, if that be desired, than we did upon the last occasion. Take, for instance, the study of the defence of a position. I do not see why the Home District should not pick out a select detachment of its own Officers, say ten, fifteen, or twenty. I do not see why those Officers should not put themselves in the hands of some thoroughly skilful Chief Umpire—some Officer of experience, like your lordship—and send a challenge to a representative tactical society from some different part of England, we will say to Scotland, or to Lancashire, and ask them to furnish a team of competent Officers to work out the attack of the same position. Let the two rival schemes be worked out on the same day; let the Umpire-in-Chief be aided by two assistants, acting for the two sides; and I take it the chief work of those two latter Officers would be simply this: to prevent the

competing Officers, when it fell to their turn to report their designs in detail, from bringing forward as part of their original scheme any afterthoughts which only occurred to them after they had heard related in open court the intentions of their adversaries of the moment. In that way I do not see why we should not get a very efficient idea of the attack and defence of a position, worked out by two rival teams upon the same day, and we might all find great benefit from every stage of the process. I think those are the principal points on which I was most desirous of commenting. There is, in addition, one very natural fallacy in connection with our exercise to which my attention has been called. It has been said to me by two or three Officers, "when imparting tactical instruction on the ground, you are so apt to assume that you can do what in practice could not possibly be done within the time. An Officer engaged in the exercise is so apt to say, in an airy sort of manner, 'I should demolish this wood, destroy that bridge, throw down these houses.'" That, to any one who has not seen us at our work, is a very natural objection, but I can assure you (and I ask Officers present on those occasions to bear me out in what I say) I *never* allowed a single scheme to be put forward embodying the destruction of a wood, or a bridge, or buildings, which could not actually have been done with extreme ease under the assigned conditions of time, and labour, and equipment. I think all Officers will bear me out in that statement.

Brigadier-General HAMILTON: I have listened to this lecture with great interest. I regret very much that circumstances did not permit me to take part in those proceedings last February. I have been thinking within the last fortnight very carefully over a scheme for doing something in this way, not exactly as was done on this last occasion by Colonel Smith, but I had been thinking of inviting the Officers of my own brigade, as many as could come, to try and do some skeleton tactics, that is to get out of the battalions, if possible, six or eight men to carry small flags representing the battalions and the number of the Company, and in that way to carry out some skeleton tactics. I should get one or two artillery Officers to represent the guns, and so to go through the actual work which would be done. I think that would interest all those who came out very much, because these conspicuous flags about eight feet high would show the actual position of the troops as they marched along the road, or took up their positions. That is all I wanted to say with reference to that. But there is one very important point mentioned just at the end of the lecture, and that is the necessity for reconnaissance of the country roads instead of relying on Ordnance maps. The lecturer says, "The 1-inch Ordnance only was used as being the largest scale likely to be available on active service." Of course a military reconnaissance of the whole country would be a very large affair, and it would only be undertaken by the military Government of the country, but I do think one very great want that we have is a map on about the scale of 2 inches to the mile—one inch is too small to be really useful—of the country round London especially those portions which are necessary for the defence of London. Such a map could be worked up from the Ordnance Survey which has already been made and which in the first instance would be photographed to the right scale, and the further military details could then be inserted on it by military Officers accustomed to reconnaissance work. The military features that should be shown thereon are the qualities of the roads, the nature of the bridges, &c., and if necessary the maps should be treated confidentially when issued to Officers, and no opportunity should be given for their getting out of the country. At all events that I think is a very essential necessity in the defence of the country.

Colonel CAVE: I think there cannot be a doubt of the value of exercises of this nature. The individual Officer, and especially junior Officers, decidedly learn more tactics than they can by any other method in the same time. There is, however, a great difficulty in getting Officers to instruct us as Colonel Smith did last year. I am afraid he will not be here next year. I hope his successor or some one will be found, if he cannot come himself, to give us the same kind of instruction. I think, my lord, if you will kindly bear this in mind you will greatly help us. We are in the hands of the military authorities in this respect. There is another point, not so much in connection with the exercises, but with the deduction that Colonel

Smith drew from our four days' practice, that I should like to bring before the notice of this meeting, and which is really of very great importance. Colonel Smith concluded that of all the different systems of fighting,—the defence pure and simple, the defence taken up simply with a view to a subsequent counter-attack, or the attack pure and simple, the last was decidedly the best. We have all heard from military authorities during the last year or two very much to the same effect; but Colonel Smith concludes his remarks with these important words: "Does the rapidity of our mobilization give grounds for hope that we could collect our forces in sufficient time to strike that blow before he reaches the foot of the North Downs? If you measure the time he must take to prepare for his invasion, to cross the Channel, to seize unguarded spots, and then to disembark stores and men enough to enable him to move; add to this the actual time spent in marching northwards delayed by small parties, and you will agree with me that the time *should be* ample." That, of course, begs the whole question, Is it ample? It is a matter manifestly of mobility; that is, mobilizing our forces, getting them together in all their proper proportions, with all their necessary munitions of war, and, subsequently, field mobility, so that they can move anywhere when assembled. I venture to think it is a very moot point indeed whether we are sufficiently mobile. Some few battalions of Volunteers have devised schemes of mobilization so far as their battalions are concerned and some have practised it. It is valuable even to devise a scheme, but that is not of much use unless it is practised. Anything beyond the mobilization of a battalion is very seldom or never attempted. I think, if we are to be sufficiently mobile we certainly ought to practise coming together in much larger bodies. Practically now beyond a brigade of infantry, we scarcely ever do anything in the way of really mobilizing our forces. A few brigades of infantry sometimes are brought together, but without artillery, or with a very inadequate portion of artillery and cavalry. Next, we come to the great question of mobility in the field, little or nothing is done to this end; even the Regular Forces, if I may say so with great deference, are scarcely to be called a mobile field force. We were told at the last Autumn Manœuvres that the Transport Department deserved great praise and credit. I have not the least doubt that with the very inadequate means at their disposal, they did deserve the very utmost credit. But what did they achieve? The transport available for the whole of the First Army Corps took about six weeks to move material 30 miles from Aldershot for two divisions of infantry. I think that is sufficient to show that it is desirable to call the attention of the Institution and, so far as we can, of the Authorities to the subject. If we are to be in a position to assume that independence of attack our lessons teach us, more attention must be paid to the question of mobility.

Captain KING: My lord and gentlemen: As one who happened to be present at least on one of these days at Ockley, there is only one thing I should like to mention. General Hamilton rather covered the same ground, but I do think, especially on that third day, the Thursday, the defence of Leith Hill, that had each of the battalion commanders been provided with a few small flags to mark the ground where their battalions were supposed to be stationed, it would have added very much to the simplicity of the whole manœuvres; we should then have much more realized where the men were supposed to be. Going round with Colonel Smith afterwards while he was criticizing the positions, it was difficult, standing perhaps 400 yards from the position where the battalion was supposed to be, to realize what ground the battalion commander wished to take up, and I said at the time, in a conversation with Major Satterthwaite, that it might be got over by marking the ground in some way. It is not easy when you are out in the field to realise exactly the position. An Officer raises his hand and says, "My battalion is between such and such a point;" it is rather difficult quite to understand where he meant it to be. As only a very junior member I did not quite like getting up to make that suggestion, but it seems to me that something might be done in that way. The only other thing I should like to say is this, Major Satterthwaite mentioned the hospitality of the country gentlemen around, and as one who received that hospitality, I should like to put on record how kindly we were entertained in the neighbourhood.

Major SATTERTHWAITE: I think there are very few points which have occurred

which require an answer from me. The first thing I would say is that I do not hold up this species of instruction as the *only* way to make a modern Officer. It is quite impossible to teach an Officer, or for an Officer to learn the *actual handling* of his troops by this method of instruction; he can only learn the principles by which, if once got inherent into him, he may be able to handle the troops, if he has the opportunity of doing so. With regard to the season at which these exercises took place, it is necessary to choose a season when as little damage as possible may be done to crops, and also it is necessary to choose a season that will not interfere with our summer drills. We had isolated days in the summer last year, and it was found difficult to get the Officers together. Of course it must also be remembered, whether the exercise is undertaken in the summer or winter, that it is practically necessary to use a whole day, and it is not everybody who can spare the time. Officers are very likely to be able to make arrangements to be away for two or three days where they may not be able to get away for a single day. I may mention the name of "The War Game in the Open" was not of our choosing, but it was coined by the correspondent of the "Daily News," Mr. Pearce, who was down with us and took an active interest in the work. With regard to what Colonel Smith has said about inter-society matches at this sort of kriegsspiel, I think, perhaps, it would be better to begin it rather more humbly with inter-battalion, or, possibly, inter-brigade exercises of the same sort. I do not think any of the other tactical societies in the provinces have undertaken any work of this sort; and we all know that when a great competition is announced in the papers, and is talked about in Volunteer circles, people have a good deal of diffidence in coming forward to undertake work to which they are not accustomed. And in consequence I think it would be better first for each society to initiate amongst its own ranks some such exercises between battalions, or, better still, between brigades. The points mentioned by Captain King and General Hamilton, with regard to the flags, are, in my opinion, most useful. Captain King mentioned to me on the day at Leith Hill that it would be advisable. The suggestion was duly noted, and I hope another time we shall be able to arrange something of the sort. I think also General Hamilton's suggestion with regard to the 2-inch maps with the character of the roads marked on them would be most valuable. There is nothing else for me to say, my lord, except to thank this meeting for the patience with which they have heard my somewhat dull remarks.

The CHAIRMAN (Lord METHUEN): Ladies and gentlemen, this lecture, and the discussion that has followed, has, I think the three great recommendations of a good speech: it was short, it was to the point, and all the speakers were well heard. Now, regarding the initiation that has been given to this movement of outdoor work I look upon it as very valuable and essential. I have thought ever since I came back from Germany that we in England, who have not the same opportunities of working bodies of troops as foreigners have all over the country on the Continent, should, even more than foreign Powers, make use of the *Uebung's Reise*. I think Generals of Districts might take out their senior Officers and do very much the same work done by Colonel Smith and his class last February. But I think it is open to question whether Officers who are never likely in practice to command more than companies or battalions, are not commanding in theory, forces larger than they need ever trouble themselves about. I recognize quite clearly that to do this work with a company or a battalion is not so interesting as it is with a brigade or with a division, but I think that depends very much upon the Officer who provides the scheme. I believe that a man like Colonel Smith, of his ability, with the amount of learning that he has in his head, could perfectly well give schemes for companies and battalions which would meet the purpose, but I think it is a question—I say no more—whether at war games indoors or out in the open, there are not many Officers who are not really running before they can walk, and whether in some few cases they have only a theoretical knowledge which has not the real value of the knowledge possessed by the practical Officer. Colonel Smith stated that he could quite imagine a man with all the theory in his head finding himself with no rule that will fit in. Colonel Smith can remember as well as I can remember the very remark that Verdy du Vernois made at Nachod, when he was on the top of defile so soon as the Prussians had gone through, and said, "I found that all my theories, all the rules

that I had ever read were of no assistance to me in the position in which I was placed." The result was he had to use his head. Then Colonel Smith speaks of the defensive, but I reply that the English Army in old days always used the defensive offensive. If you look at the Peninsular War no doubt we were often on the defensive, but surely no army that ever existed dropped the defensive to take up the offensive sooner than we did. And I must say wherever the English Army goes we need never have the least fear that we shall assume only the passive defensive. Allusion was made with regard to different districts organizing a system of competitions in the attack and defence of positions. I agree with the lecturer. Let us begin far more simply, let battalion Officers work against each other, or, better still, let our Brigadiers—we have General Hamilton and others who are selected with a thorough knowledge of the work—let them work against each other. There is a difficulty and expense in working out matters on a large scale which is very often fatal to good schemes. The same remark may be made with regard to Colonel Cave, who spoke on the question of mobilization. I quite admit that it is most essential for us to do all we can to make our Army mobile, but it is a question of expense and of time, and of difficulties which are really in this country almost insuperable. Colonel Smith quoted the different ways in which you can learn military work, but he dropped one, and, in my mind, one of the most essential of all; that is, walking over battle-fields. You all go to the battle-fields of 1870; but I have also been to the battle-fields of 1866, and, as far as I can make out, nobody seems to go now to what appears to my mind some of the most instructive ground to walk over, particularly if you are provided with a book which is invaluable, Kühne's "Wanderings over the Battle-field." If you take that book in your hand, if you follow the crosses marking the graves, and you see the ground where the different companies and battalions were engaged; if you go to Trautenau, to Skalitz, you will go to a lovely country; you find inns close at hand, you will be made fairly comfortable, and you will have in your hand the very best guide I know to the battle-field. I need not take up any more of your time. As I have said before, I thank Major Satterthwaite very much for his lecture, and I have also to thank all those who have taken part in the discussion. I wish, in conclusion, to say that we owe a very deep debt of gratitude to the Volunteers. You help us all. There is an amount of go and initiative about you, that makes it of great advantage for any Regular Officer to have anything to do with you. And I come back here, after being away for some years, and find the reconnaissance work, the war game, and all those schemes that we had in our minds in former times now in existence. I think the war game, carried out as it is under the able guidance of Colonel Hale, must be of immense profit to this district, and I trust if Colonel Smith is not here next year that his successor will carry out the good work that has been organized by him; and when Colonel Smith leaves this district, it will always be a pleasure to him to feel that he has initiated one of the most valuable and best schemes that have been introduced into any district in England.

Friday, May 27, 1892.

LIEUTENANT-GENERAL SIR MARTIN DILLON, K.C.B., C.S.I., in the Chair.

COMBINED TACTICS.

By Colonel H. M. BENGOUGH, C.B.

Introductory.

IT is, I confess, with considerable diffidence that I appear before you this afternoon, and for two principal reasons. In the first place, this is the first occasion of my having the honour of addressing an audience in this theatre, and in the second place, I cannot but feel that the subject I propose to offer for your consideration is one which may be thought, perhaps, not to concern, or even, perhaps, to interest, Officers generally, and treating, as it does, of the combined action of the three arms, it may be thought to be, in some sense, beyond, or, at least, without, the strict sphere of knowledge that can be expected from an Officer of any particular arm. With regard to the first reason, I trust that I may rely somewhat on the indulgence of my audience; and for the second, I would say, that it is because I am convinced that it is possible for every Officer, to whatsoever arm he may belong, cavalry, artillery, or infantry, or of whatever rank he may be, General or Subaltern, each in his own degree, not only to interest himself advantageously in this subject, but that it is distinctly the duty of every Officer to study this subject. No doubt the study of technical details connected with each arm is impossible for any one who has not been regularly apprenticed, so to speak, to the arm; but these are not the points with which we are concerned to-day. We have to deal with the general tactical principles of the three arms, and these general tactical principles, like all great fundamental principles, are, and ever must remain, unchangeable. Therefore, it is that I can offer you no novelty. We can but follow in the track trodden by those great masters of war who have reduced to rule the principles that must govern all right tactical and strategical action. Let us consider one of these, the most important, perhaps, of all tactical principles, the principle consecrated by the genius of a Napoleon, and which, if not first enunciated by him, received from him its most complete development—I refer to the grand old principle of the concentration of a superior force at the point of attack, and the selection of that point of a vital one. This axiom is capable of almost indefinite expansion. It is true whether the superiority be that of fire or shock, of numbers or of moral: it is equally true as applied to the action of each arm taken individually as of the three arms in combination. It is exemplified in the action of attacking cavalry, where a sudden blow at a decisive point, followed up with due supports, is a recognized condition of success. It appears in the modern teaching of the concentration of artillery fire on successive points in an enemy's line, thereby obtaining a local superiority; and it stands out clearly in the principle that underlies all sound forms of infantry attack, a principle so well appreciated by that great practical soldier, General Skobeleff, viz., that of a continuous accession of supports to the fighting line.

Some may be inclined to ask to what purpose is it that I should devote myself to a study of combined tactics when I may probably never have the opportunity of commanding anything on service more important than my own squadron, company, battery, or battalion? I would say in reply, first of all, that it is impossible to foresee what may be in store for any of us in war-time. We might then have bitterly to regret the want of knowledge and experience that might have enabled us to strike an effective blow for our Queen and country; that want of skill and resource which makes itself so sadly felt when the one chance comes in a soldier's career, and probably comes not again.

In connection with this point I would quote two extracts, one from our new Infantry Drill Regulations, the other from a recent number of a Service journal. The former runs: "On service it will often happen that an Officer commanding a company who does not know the principles governing the employment of the other arms must fail to gain all the advantage possible from his own arm." And the other to the same effect: "Even junior Officers must look a little beyond their own immediate sphere if they are to be equal to the duties the eventualities of war may thrust upon them; a Subaltern has often, in our small wars especially, to show himself a General ere he is a Captain." But though we may not possibly be called on to command a mixed force ourselves in the field, we may, some of us, serve on the Staff of Generals who do, when the knowledge I am speaking of would be invaluable.

But I am well content to rest my case on the principle laid down in our new Infantry Drill above referred to, that no Officer can do full justice to his own arm without some knowledge of the working of the sister arms. And does this knowlege generally exist? I think that few will contend that it does, and that numerous examples to the contrary will arise in the memory of many of us, both in the field of war and of manœuvre. Let me quote briefly two from my own experience.

At the hapless battle of Isandhlwana a mule rocket battery accompanied Colonel Durnford's column to the field of action. On arrival, the cavalry hastened to the front; the rocket battery, left to itself, advanced to a hillock with the intention of coming into action. The hillock was lined on the far side by the enemy. On the battery topping the hill the Zulus fired a volley, killing the Officer commanding the battery and the quartermaster-sergeant. They then charged with the assegai, and none of the battery were ever seen again.

The other example I would quote is from the field of peace exercises. At a rifle meeting in India a prize was offered for a tactical field firing competition, the competing teams to consist of a company of infantry and a section of artillery; marks being specially allotted for the manner in which the tactical part of the exercise was carried out by either arm. The position to be attacked was not visible from the rendezvous, which was in a wood. The little column started with an advanced guard, the artillery being in rear of the infantry column. Shortly after debouching from the wood the position became visible.

The guns at once trotted away to some rising ground and opened fire. The infantry continued to advance and eventually formed for attack behind the same mound from which the guns had opened. From thence, without getting the range from the artillery, and without the Commander arranging on any combined action, the infantry advanced straight on the position. In doing this they soon masked the artillery fire so that the guns had to cease firing, and the assault was carried out by the infantry without any further assistance from the artillery. It is true that when the fact of the exclusion of the guns from the fight was realized the artillery Commander determined to change position, but too late to affect the issue of the day.

In the next contest the artillery avoided the error of clouding the infantry fire by taking up a first position well to the flank, but without escort, and again without any understanding with the infantry. So resolute was this artillery Commander to support his infantry closely (thus recognizing, but misapplying, the principle of co-operation) that he brought up his guns to close rifle range of the position whilst his own infantry were still at a distance, and would probably, on service, never have got into action at all.

Now here we see in a simple combined exercise of two arms, nearly every possible rule of tactics violated: guns placed in the rear of a column on the march in the presence of an enemy, no reconnaissance, no plan of attack, no artillery preparation, no escort for the guns, no ranges taken from the artillery by the infantry, no tactical support of the infantry by the artillery; and yet the Officers in command were all intelligent, and I have no doubt well versed in the drill of their own individual arm, but simply they had never been practised in working in combination with another arm.

It is common and natural for soldiers to endeavour to forecast the results that may be achieved in the next war by the introduction of some new arm or machinery, or some change in the tactical formation of one or other of the three arms. Is the next campaign to be won by an improved rifle, as Frederick's early victories were, to a great extent, due to his iron ramrods, or as the German successes over the Danes were won by their breech-loaders, or as the French hoped to annihilate the Germans in 1870 by their mitrailleuses, or is the campaign to be decided by a new formation of battle tactics, as in the case of Frederick's lines or Napoleon's columns? He would be a bold man who would offer to predict on these points; but this I think we may venture to affirm, that the Commander who in the next war succeeds in giving the most complete development to the three arms in combination will have an advantage that cannot very easily be overborne by any superiority of weapons, or of numbers, or of formation.

What, I would ask, to make use of a homely simile, would be thought of a carpenter who, when desired to make a box, and provided with, say, a chisel, hammer, and saw, should lose both time and perfection of workmanship by using one or perhaps two of his tools only instead of all three; and when it comes to a question not of boxes but of battles, is not the Commander guilty of something worse

than neglect who fails to utilize to their fullest extent all the weapons in his armoury?

And yet military history furnishes numerous instances of such neglect; indeed, it is only in the battles of the great masters of war, and not always in them, that we find examples of the full development of the use of the three arms; and in applying this experience we should remember that the perfection to which the power of offence of artillery and infantry has now been brought renders it all the more essential to give that power its full effect, for in the same ratio in which these two arms have increased in effective action do the consequences of their non-utilization react prejudicially on an army that neglects to use them. Even Napoleon, if we may dare to criticize a genius so superior to all criticism, notwithstanding the complete knowledge of the value of tactical combination that he possessed, cannot be said to have always utilized the three arms to their fullest advantage. A skilled artillerist himself, he placed a high value on the power of that arm, and consistently practised the preparation of a position by artillery fire, and the massing of guns on important points, but his cavalry was frequently squandered in a wasteful manner, or not used at important crises of a fight, and the cavalry reconnoitring service was generally imperfectly carried out. The infantry, too, was used rather as a battering ram than as an arm whose power of offence is fire. And this, notwithstanding the Napoleonic dictum, "Fire is everything, the rest is of little account" —this axiom now so often quoted was, however, I think applied by Napoleon not to infantry fire in the attack or defence of a position, but to infantry fire in resisting cavalry charges.

We must not, of course, forget the vast difference between the fire weapon, cannon or musket, of those days, and the rifled gun and magazine rifle of to-day. A century ago, 200 yards was a long range for a musket, and the effect of artillery was indeed little more than "vox et præterea nihil;" but this difference, though it may account for the want of development of the power of those arms in the tactics of the past, makes the combination of the three arms in the present day not less, but more, necessary; the more delicate and accurate the components of a machine, the greater the necessity for perfection in their combined action.

Reviewing the occasions, happily few, when a British force has been worsted in a fair field of battle, the cause can generally be traced to a failure in tactical combination, such, for instance, as Chillianwallah, where that gallant, but impetuous, Commander, Lord Gough, failing to employ his guns, advancing with exhausted troops against a brave enemy strongly posted, sustained a rebuff but little removed from a defeat; and again at Maiwand, where both tactics and initiative seem so unaccountably, and so little in accord with British traditions, to have passed to the side of the enemy.

The Germans, in the war of 1870, and in their teaching prior to that war, thoroughly recognized the value of the use of the three arms in conjunction, and, for the most part, during the campaign, each arm was duly utilized. Exceptions can, of course, be quoted, as,

for instance, the failure of the cavalry of the advanced guard of the VIIth Army Corps to sufficiently reconnoitre the French position at Spicheren, resulting in the Germans finding themselves committed to an attack against a superior force in a strong position, instead of having to do with a rear guard only, as General Kamecke imagined. Again, we have the inability of the cavalry to discover the extent of the French position before the battle of Gravelotte, and the misuse of that arm on the same day, when, after repeated failures by the German infantry to dislodge the mitrailleuses posted in front of the Point-du-Jour, squadrons of cavalry were uselessly hurled up the Mance ravine at these guns, entailing certain loss and ultimate failure.

Of the want of mutual support by the three arms on the French side in the same war, examples are not wanting. Witness the absence of systematic reconnoitring by the cavalry, and the slackness of the outpost duties by all arms. Co-operation by the artillery was frequently wanting, as, for example, in the many gallant counter-attacks undertaken by the French infantry against the German right at the battle of Spicheren, which, if preceded and supported by artillery fire, might have had very different results.

The reckless manner in which the cavalry arm was expended on both sides during the war points to a want of appreciation both of the value and of the duties of that arm in battle. Indeed, the cavalry seems to have been used chiefly (with some notable exceptions) in attempting to redeem an already lost battle, or in extricating Commanders from disasters into which a want of skill or foresight had plunged them.

In the American Civil War—a war waged on both sides by troops and Commanders generally but roughly instructed in war tactics—it is somewhat surprising to find that whatever strategical errors may have been committed, as a rule, full effect was given to the employment of all arms, mutual co-operation being ordinarily afforded both in battle and in bivouac. This may be due in part to the essentially practical nature of the American character, which showed itself so markedly throughout the contest, and which must have recognized the enormous advantage conferred by a system of co-operation in battle.

But to understand the proper working of an arm in combination, we ought certainly to possess some knowledge of its own special organization, capabilities, and general tactical application. All these points, putting technicalities aside, can be readily mastered by any desirous to do so. Some suggestions as to how the needful knowledge can be best acquired will be offered at the close of this lecture.

It is impossible in the time at our disposal to-day to deal fully with this part of our subject. I may, however, be permitted to sketch briefly some of the tactical characteristics of each arm, under modern conditions.

The functions, then, of cavalry, the premier arm of the Service, are, rapid movement and shock, and the duties of protection, exploration, and foraging, when mounted, and the power of fire dismounted, or rather, the former only are the functions of cavalry proper, for it

is the action of the man and horse together that constitutes the true cavalry. The dismounted action is, as it were, an adjunct, or a temporary, though necessary, departure from the cavalry *rôle*.

I do not propose to enter into the question of the present relative value of the cavalry arm compared with the sister arms as affected by the late progressive improvements in these latter. That its tactical value in the battle-field cannot keep pace with that of the artillery and infantry, having regard to the ever-increasing accuracy and range of firearms, is clear, inasmuch as the powers of cavalry, being limited by the natural capabilities of the man and horse, are, so to speak, a fixed quantity, whereas firearms are capable, under mechanical ingenuity, of comparatively unlimited expansion; yet the time for cavalry to cease to act effectively as a tactical agent in the battle-field is still, I believe, far distant, and even what, under the stress of modern mechanical inventions, it has lost in tactical it has more than gained in strategical importance; for the long-range fire of artillery necessitates the commencement of an action at very great distances; accuracy of fire of both artillery and infantry makes an initial blunder more difficult than ever to redeem; and smokeless powder enables an enemy to conceal his strength and position until an adversary is committed to the attack. From all this it results that reliable and early information of an enemy's dispositions and probable designs is absolutely necessary before a Commander dare commit himself to a struggle; and this places on the "eyes and ears" of the Army a duty even more important than that of shock in battle.

But if this new rôle gives to cavalry a higher strategical importance, it makes also a greater demand on the training of man and horse. Boldness, celerity, cool-headedness, and steadiness in the field will remain as necessary as ever, but superadded to these, which may be called the inherent qualities of all good cavalry, must now be added greatly increased powers of intelligence, of initiative, and of resource, and a conviction through all ranks that their efforts can be of no real use unless directed towards and subservient to the success of the other arms. Instead of this do we not frequently see cavalry at field manœuvres engaging in desperate conflicts with the enemy's cavalry, useless because not based on the above principles?

I have said that to fulfil the rôle of modern cavalry effectively, a very different training to that to which our cavalry has been accustomed seems to be necessary. The highest individuality and intelligence of the trooper must be developed, that he may be able to see, hear, and report accurately the various incidents that come under his observation, understand his orders, and appreciate the responsibility that rests on his shoulders. Is our present training of cavalry calculated to create efficiency in these respects? I fear that few will contend that it is. That a trooper is taught to ride, and drill, and cut the sword exercise is true; but this is surely but an elementary training for a cavalry soldier, and it must be remembered that a British soldier by very virtue of his civilization is, without special training, little fitted for duties that require the exercise of the natural instincts, such as in our Cavalry Regulations are somewhat vaguely defined as

"detached duties," viz., to find his way from point to point across country by day and night, to hang on to an enemy without being discovered, to combine the resource and finesse of a hunter with the steadiness and discipline of a trained soldier; such are some of the qualities required of good cavalry. To attain them, systematic and practical instruction of Officers and men, from the first simple duties of scouting to the higher ones of reconnaissance, is necessary.

All true cavalry soldiers will, I feel sure, have hailed with satisfaction the first great step for the practical instruction of their men that has been lately taken by the introduction of the squadron system of field training. Much is still wanted to enable the training of our cavalry for war to be efficiently carried out in England, such as a suitable ground for manœuvring, say, a cavalry Aldershot in the north of England, an increased number of horses in cavalry regiments at home and at the Canterbury depôt.

The question of the armament and equipment of cavalry is one closely allied to its tactical employment, but it is too large a subject for us to enter on to-day. Sword, lance, carbine, pistol, and even bayonet, have all their advocates as weapons for cavalry, and there is almost an equal variety of opinions as to the best methods of carrying these weapons. It is pretty generally accepted, I think, that in view of dismounted duties being now so frequently demanded of cavalry, the best place for the sword is on the saddle, but as this leaves the trooper defenceless when separated from his horse, some weapon should undoubtedly be carried on the person when going into action.

The evil condition of a trooper thus separated from his arms scarcely requires illustration, but as a picture is often the most impressive manner of conveying a lesson, I may perhaps be permitted to quote an apt illustration of the advantage of a trooper being always ready for an emergency, in a graphic scene from Archibald Forbes' "Experiences of the War between France and Germany." "Just as we entered Saarbruck, two of the German Black Hussars made a dash to cross the old bridge into the town, not knowing whether there were Frenchmen over the way or not. A French piquet was in the Schloss Platz and a few of the men under a sous-officier ran down the slope to the bridge head to have a crack at the hussars. When these saw the red legs coming, they went about and rode back. Chased on to the bridge by the latter, one of the horsemen's horses fell and threw his rider. As he lay prostrate, the French sous-officier sprang forward, his sword upraised to strike the hussar as he rose. The gallant horseman, however, was on his legs with one bound, with another quick movement he levelled his slung carbine, drew the trigger, and the sous-officier was a dead man."

In India many methods have been tried of carrying the carbine on the person, but none have as yet, I believe, been officially adopted.

I do not propose to refer at length to the dismounted duties of cavalry, important though they are, as they still have a certain controversial aspect, and I wish to avoid subjects of controversy as much as possible. My own opinion as a layman, such as it is, has indeed

undergone a change since I have been convinced that for cavalry to perform efficiently perhaps the most important of all their duties, that is to say, the duty of forming a screen in advance of the main body, they must be able to dislodge any hostile bodies of dismounted cavalry or mounted infantry holding villages, bridge heads, defiles, &c., which would otherwise check their onward progress. I for one used to think and to maintain, as indeed is still maintained by some, that it is impossible to teach a soldier to consider himself at the same time invincible in the saddle against infantry, and equally invincible on foot with carbine in hand. But the fact is, that the idea of the invincibility of cavalry against magazine rifles must be given up Cavalry may still have opportunities of charging broken or shaken infantry, and they may even be required on an emergency to sacrifice themselves by attacking unbroken infantry, but the question of the invincibility of cavalry when opposed to accurate, rapid, and disciplined fire of modern rifles must be abandoned for ever; though it may sound something like a paradox, the only way to ensure to cavalry that independence of movement indispensable to true cavalry action is to train them to a temporary abnegation of the true cavalry *rôle*.

But let us pass on to consider some of the more prominent tactical characteristics of modern field artillery.

The importance of artillery in the battle-fields of the future will, I think, be found to have increased in a greater ratio than that of any of the three arms. So vast indeed is the difference in training and matériel between the artillery of to-day, to look no further, and that of a quarter of a century ago, that it would be impossible to foretell its effect in the next campaign. It used to be said that the effect of artillery fire was principally moral; it is now no longer merely moral, or rather it is now more moral than ever, because more material.

Far ranging, accurate shooting, and quick-firing guns, high velocity shrapnel, and high explosive common shell, good time fuzes, vertical fire from field howitzers and mortars, principles of concentration of fire and of forward and enterprising tactical action, and best of all practice in accurate shooting, and training in the rapid service of guns, and in the observation and control of fire, all these measures of improvement, and I daresay others that I may have failed to notice, have given such a value to this arm that guns, and plenty of them, will now, more than ever, be an indispensable adjunct to an army that hopes for victory in the field.

But the connection of this arm with the sister arms is a very close one. Artillery is essentially an arm of co-operation. It must always, as a rule, be dependent on one of the other arms for its own close defence, although instances are not wanting, especially in the Franco-German War, of artillery repulsing by its own fire attacks of both infantry and cavalry. But the dependence of artillery on the other arms does not of itself imply the necessity for a special escort; for artillery may be tactically defended by the near presence of a formed body of either of the other arms. The following golden rule is

from an artillery Officer of experience, viz., that in the attack infantry should hold themselves responsible for the safety of artillery; whilst during a retreat artillery should stand by infantry to the last, even to the loss of their guns. United with infantry, artillery can do and dare anything. Witness the manner in which the German guns were thrust into the very firing line of infantry in 1870. This bond between the artillery and infantry is so distinctly emphasized in the German Army, that guns are forbidden to change their position without the consent of the Commander of the force to which they are attached.

But it is, after all, the infantry arm that must ever remain the great arbiter of battles; and this because of its great power of fire both in offensive and defensive action, its capability of moving over any kind of ground, and its rapidity in coming into action. But infantry are slow, very slow, in movement, and it is this very slowness which is one of the points so important for the other arms to recognize and to make allowance for.

Let us consider for a moment what are the requisites for good modern infantry. Discipline, including that most important branch of discipline, fire control in the field; good shooting, not only at a target at known ranges, but at a moving object at unknown distances, or, which is still more difficult, at an object firing at the firer; intelligent use of cover, and good marching powers: the whole cemented by that best of all soldier-like qualities, endurance. In one of these qualities, at any rate, our infantry have made great progress of late years, and in the term infantry, I would wish to be understood to include our reserve forces. I allude to fire discipline. I was present at the late Easter manœuvres at Dover, and was very much struck with the great advance made by the Volunteer regiments in this respect as compared with the last time that I saw them, some ten years ago, when the very meaning of the phrase "fire discipline" was almost unknown. This year I noticed that section commanders almost invariably named the distance and the object to be fired at, while the men fired steady volleys, and paid attention to sighting and aiming, and this amongst a mob of onlookers sufficient to unsteady the best of Regular infantry.

Whilst speaking of the tactical arms, I must not omit a reference to what may now be called the fourth estate of the military hierarchy, the mounted infantry, omitting mention of that most important auxiliary, the engineers, whose action is not strictly tactical, and therefore does not come within the scope of our subject.

This branch of the infantry arm has now, as you know, a recognized place in our military system. It has passed through many vicissitudes, and has suffered, perhaps, more from the misplaced zeal of its friends than from the sneers of its opponents. It is no theoretical novelty, but has gained its present position by right of good service in the field. The arm with which this tactical youngest son has very unjustly been put forward as a rival (I refer to the cavalry) has now accepted it as a very useful supplement and support, and, I think, even recognizes that it is to this arm that it must often trust

to ensure a fair field for the exercise of its own proper functions as cavalry.

The action of mounted infantry in its tactical aspect is identical with that of infantry. Its arm is the rifle; the horse, or may be the mule, which transports it is merely the means of its more rapid locomotion; but whether when acting as a mass of infantry brought suddenly into action on some particular and important point, or when supporting the sister arm of the cavalry, it has fully justified its claim as a recognized tactical agent.

It remains now for me to attempt to present you with a picture of the working of the three arms in union on a modern battle-field, and to close with some suggestions for attaining the objects advocated in this lecture.

Let us imagine then a force of the three arms acting on the defensive, and a similar force advancing to discover the position of the former, and, if opportunity offers, to attack it.

Let us suppose that the advancing cavalry brigade is preceding the column by a day's march, and has, shortly after starting in the morning, been checked by an unfordable river of which the further bank is held by the enemy, but apparently not in force. It is important to cross without delay, but the only bridge within 10 miles has been destroyed. A few boats are, however, procured, trees are felled, and rafts constructed from these and from material found in the nearest villages. The men have been practised in raft making and in swimming their horses, and in two hours' time a passage is effected under cover of the fire of the horse artillery and machine-guns. The cavalry pioneers and a body of mounted infantry are left to repair the bridges and to hold the passage until the arrival of the main column, whilst the cavalry press on, sending back a cyclist orderly to inform the General Commanding of what has been done. It is not long before the Officers' patrols report the presence of formed bodies of hostile cavalry, stating the approximate force and the presence or absence of guns.

Then follows some manœuvring between the two hostile cavalries, resulting, let us suppose, in the attack gaining some substantial advantage, and forcing back the defending cavalry on their reserves. On following up this first success with a view to ascertain the position, strength, and intentions of the main body of the defence, a smothered report and a bright flash from a height some 2,000 yards distant, and an empty saddle or two in the cavalry column bring the brigade to a halt. It is clear that the hill is occupied, but by what arm and in what strength it is impossible to say, as there is neither report nor smoke sufficient to indicate this.

Rapid decision on the part of the cavalry Commander is demanded. Ordering the horse artillery into action on the spot, and leaving a company of mounted infantry for its protection, the cavalry brigade is retired rapidly to where some undulating ground offers shelter. From this spot reconnoitring parties are despatched, which report that ground favourable for a dismounted attack exists, leading up to a flank of the enemy. The horse artillery are recalled by signal, and

the position that they are to occupy in the attack is pointed out to the Commander. A portion of the brigade is left mounted under cover, whilst the remainder, with the machine-guns and all the mounted infantry, are moved to the flank from which it is intended to attack the post. Information of the intention to attack is sent back to the Commander of the forces, stating that the post obstructs the further advance of the cavalry and the prosecution of the reconnaissance of the enemy, and that it appears to be an isolated outpost not defended by guns, and not protected by the fire of the enemy's batteries.

The first few rounds from the horse artillery guns are replied to by machine-gun fire from the hill; but the new horse artillery gun, although shorter and lighter than that of the field batteries, and of less initial velocity, is sufficient to show the magazine-guns that they are overweighted, and they soon cease firing and are withdrawn behind the hill. The guns of the attack continue their fire on the hill from a flank where they are not masked by the now advancing dismounted troopers, whilst the machine-guns have found a similar position somewhat more advanced on the other flank. The assault is successfully carried out; the enemy, consisting of a couple of regiments of dismounted dragoons armed with carbines and bayonets, with two machine-guns, seem at first inclined to await a hand to hand encounter, but the bayonets of the mounted infantry, or the appearance of the mounted cavalry reserve moving round the hill against their rear, proves too much for them, and they run to their horses, mount, and retire in fair order, carrying off their machine-guns.

The Commander of the Force has by this time arrived on the field and directs that the captured post be held by the mounted infantry and the machine-guns, which are to entrench themselves as far as time and tools will admit.

In the meantime the reconnaissance by the cavalry is continued; this proves a matter of the greatest difficulty. Officers' patrols, under selected leaders, are sent out with directions to try and gain the enemy's flank or rear, while the brigade manœuvres in support and occupies the attention of the enemy's cavalry, which at last ventures to try conclusions by another attack; victory, through the opportune action of a flank squadron, again declares for the attacking force, and by pushing home this advantage the cavalry Commander succeeds in drawing fire from the guns of the main position, and he is thus enabled to gauge roughly the extent of ground occupied by the enemy. It is noticeable that the position of the enemy's batteries is indicated not only by the bright flashes from the guns, but by the thick clouds of dust that, owing to the sandy nature of the soil, arise at each discharge.

Sketches of all the ground under view are made, and on the return of the reconnoitring patrols a fairly complete report of the extent of the enemy's position, the position and number of the batteries, together with a description of the most favourable line of attack and of the positions suitable for artillery, is submitted to the Commander of the Force. The above report tallying with sufficient

accuracy with the observations made by the balloon section, which has managed to make an ascent by a captive balloon from near the reserve, the Commander is enabled to decide at once on his action. His intention is to threaten both flanks in force, but to make his real effort against the enemy's centre, by breaking through there and seizing the road which leads directly from this centre to the rear, and forms in fact his enemy's main line of communication.

He accordingly issues written instructions to his cavalry and artillery Commanders, pointing out personally to the latter where he wishes the guns to come into action, the line of their advance, and the exact spot on which the fire is to be concentrated for the final effort, and enjoining on the former to continue to harass the enemy, and to hang on to his cavalry, not forgetting to post Officers' patrols in rear of the position so as to gain information of the arrival of any reinforcements during the action, and to report any indications of a retreat. Similar instructions are sent back by two Officer orderlies to the Commander of the infantry column, who is informed of the intentions of the General Commanding, and is directed to advance as rapidly as possible.

The main column of field artillery and infantry had been delayed by the passage of the river alluded to, but the field batteries having crossed have pushed on at the first report of firing in front, which had been passed to the rear by cyclist orderlies posted in groups so as to maintain communication with the cavalry column, and were at this time some 8 miles distant; but horses and men have been accustomed to long and rapid marching, and so, escorted by a company of mounted infantry, the field guns cover the distance within the hour, and take up a position opposite the centre of the enemy's line of battle, obtaining the range from the horse artillery, which, having drawn the fire of the position, is now withdrawn from action.

(It may be noted that an artillery position in front of the centre has been here selected in preference to one on a flank, in accord with the opinion of Colonel von Schell, as given in his "Tactics of Field Artillery," and that of General Brialmont in his "Combat Tactics of the Three Arms," on these grounds, viz., that in a flank position the artillery is *en l'air*, covered only by the cavalry, and, though advantageously placed for taking the enemy in flank, it is itself liable to enfilade fire; whereas a frontal position facilitates the concentration of fire, is the shortest and quickest way into action, the guns are tactically protected, and a very effective fire can be directed on both wings of the enemy. The front of the batteries must, however, be kept clear of infantry until near ranges are reached.)

The mounted infantry, leaving their horses under cover, are pushed well to the front, and drive in the enemy's skirmishers, who had already begun to annoy the guns.

A steady concentrated fire directed successively on different portions of the enemy's artillery line results in partially silencing the guns, or at any rate in causing their withdrawal under cover of the reverse slope of the hill. The high-angle fire of the field howitzers and mortars on either side is somewhat disappointing. The noise of a

60-lb. shell bursting overhead is certainly found to be sufficiently alarming, but the vertical fire of the defence is wanting in accuracy, especially when directed against troops on the move, and the observation of fire on the part of the attack is found very difficult. It is, moreover, suspected that the defence have provided themselves with some species of overhead cover.

By this time the advanced guard of the main column has arrived, and the infantry battalion composing it is at once sent forward to a convenient knoll, whence a long-range fire by company volleys is kept up, in conjunction with the artillery fire, on the enemy's line of entrenchments, whilst the infantry column forms for attack. The deployment completed, the infantry advanced, covered by a light cloud of skirmishers, at first in small columns, taking advantage of the undulations of the ground. As the hostile shells begin to tell these small columns shake out into an extended line. On the enemy's rifle fire becoming felt the skirmishers in front of the line lie down and await the coming of the fighting line, which, at about 800 yards, opens with steady and deliberate volley fire. Up to this time the front of the artillery has been kept clear to allow of an uninterrupted fire being maintained, but as the infantry approach the zone of aimed rifle fire this interval is closed by a battalion from the reserve.

As the infantry advances the artillery moves to a second position, and concentrates its fire principally on the point selected for assault, but at the same time continues to occupy the enemy's attention by a fire along the whole line. When the infantry attack has progressed to within short range of the position (400 or 500 yards) some of the guns again advance and take up position at about 700 yards range, whilst the remainder continue their fire on the selected spot, firing where necessary and possible over the heads of the fighting line. When this no longer can be safely done the artillery direct their fire on the enemy's reserves, whilst the artillery Commander, with a portion of his batteries, holds himself in readiness to advance with the infantry on to the position itself. The attack suffers much from the absence of smoke cover, and the power of accurate concentration of fire is found barely to counterbalance this disadvantage. The Commander of the Force is in direct communication with the Officers commanding brigades of all arms by means of signals, heliographic or flag, or perhaps telephonic, and is kept informed by cavalry and by captive balloon reports of any changes in the dispositions of the enemy. A counter-attack undertaken against one of the flanks is, thanks to the timely information thus afforded, met and repulsed.

The time for a decisive movement is approaching; every weapon is directed on the spot destined for assault. Guns, machine-guns, and magazine rifles all combine to pour in a continuous storm of lead. The reserves are held in readiness to strengthen the assaulting line. The cavalry is already hovering around the enemy's rear. A fire, still well sustained, is returned from the trenches; the crisis cannot last. The Commander, who has kept his finger on the pulse of the fight, recognizes that the moment for the

supreme effort has come; the reserves advance in a steady line, with bayonets fixed, the bands playing the regimental quick-step; the sound of the old familiar airs is borne to the fighting line; every man nerves himself for the coming struggle; the whistles sound, the firing ceases, and, as if by one impulse, the human wave surges forwards, is checked here and there for a moment, and then a hoarse British cheer announces that the position is won.

The capture of the key of the position does not, however, in itself mean complete victory; the three arms are still required in combination to guard against a counter-attack, to complete the success won, to press the pursuit.

Whilst the infantry reserves and the guns that have accompanied the infantry at the assault prepare from their point of vantage to sweep the enemy's line on both flanks, the cavalry have forged their way to the rear of the position, and a resolute and opportune charge on the flank of the enemy's reserves at the moment of their advancing to succour the now disorganized line suffices to break their *morale*, and paralyse their attack; nothing is now wanting but a vigorous pursuit.

The above sketch may serve, however imperfectly, to illustrate the manner in which the three arms act and react on each other in a modern battle-field, and may thus assist to emphasize the necessity which it is the object of this lecture to enforce, that each arm should learn in peace-time how to support, how to co-operate with, its sister arm in war.

And I would ask is this necessity sufficiently recognized; is there any real harmony of action, or even sympathy of feeling, between the several arms in our Service; what is the aspect with which not only the rank and file, but Officers generally, of the several arms regard the tactical working of the other arms? I can attempt to describe it only from the infantry standpoint. But Officers of the other arms will, I think, find no difficulty in filling in a similar picture from their own point of view.

Does not an infantryman then regard the tactical value of cavalry with an air of disdainful superiority bordering on contempt, and accept them as allies, as fine and gallant fellows, whose appearance and dash enliven the field of action, but contribute little towards the victory? Is not the feeling that prompts the infantry, as I have seen at manœuvres, to order arms and stand at ease when a cavalry charge is being executed, a true indication of the want of tactical touch between the arms? It is no doubt desirable that an infantry soldier should regard his own arm as invincible, but it is pressing this principle a little too far when he comes to despise his own cavalry; and as regards the artillery, the rattle of the guns has certainly always an inspiriting effect on infantry in action; but does this feeling arise, as it should do, from an appreciation of the mutual relationship and dependence that really exists between these arms? I fear not.

And why then this want of confidence, this absence of touch? The cause is not far to seek. It comes simply from want of mutual

knowledge of each other, from want of practice in working together; and how is this knowledge to be gained? I would offer one or two suggestions on this point before I conclude.

1st. By self-instruction, that is by reading and observation.

2nd. By instruction from superior Officers. Commanding Officers should be able to instruct those under them in the general tactics of the other arms, in so far as they affect their own arms; General Officers might initiate and encourage lectures on the subject, and might when possible cause two or more arms to be associated together in minor tactical exercises.

3rd. By the war game.

4th. By attaching Officers of one arm temporarily to another arm.

5th. By making a knowledge of the practical tactics of the three arms indispensable for promotion to field rank.

On each of these points a few words. I have mentioned reading and observation as two important means of acquiring the sought-for knowledge. Nearly every account of a modern battle if given truthfully and in detail abounds with instances of the application or neglect of this principle; a number of such instances stored up in the mind will form a basis for action when the opportunity presents itself in the field, and as to observation, any field day will afford lessons enough to an attentive observer.

As regards the instruction of Officers by Commanding Officers, I can well remember the form of instruction that was in vogue when I was a Subaltern. My regiment was fortunate in possessing as a Commanding Officer one of the smartest drills and, indeed, best soldiers in the Service. But the drill mania was at its height. All Officers were summoned once a week to the orderly room, and put through a catechism consisting mainly of subtle and intricate questions on the evolutions of drill as they then existed. That it required a quick and ready memory to describe offhand a movement involving almost geometrical accuracy is certain, and so, no doubt, the examination was in a sort of way a test of an Officer's knowledge of his drill book, though even here book knowledge and the power of applying that knowledge in the field are of course two very different things; but was not the whole thing a sad waste of time and of mental energy, whereas the kind of instruction here advocated is, or should be made, both interesting and practical?

Regarding this question of lectures, I was rather amused to see in one of our Service journals lately somewhat divergent opinions expressed. A correspondent, writing of the French Army, noticed the great extension that has been given in that army to the system of lecturing by Officers of all grades. A correspondent, in another column, protested rather warmly against the abuse of lecturing, as he considered it, in our Service. I certainly was not myself aware that we had run riot in this matter of lecturing. In some thirty-six years' service I cannot remember having had the opportunity of listening to half a dozen lectures, excepting those delivered in this hall. At the same time I sympathize so far with our over-lectured

correspondent as to say that I don't advocate lectures being given merely for the sake of lecturing; no one cares about being lectured over much, whether from behind a curtain or elsewhere, and less so in this age, perhaps, than ever, but I think that all lectures should have some obviously practical object, whether tactical or otherwise.

3rd. The war game is undoubtedly a useful accessory in the acquirement of a knowledge of combined tactics. And here I would venture to offer my congratulations to the society known as the Home District Tactical and War Game Society, for the excellent work done by them in this direction for some years past. Their published records alone show how much valuable instruction, how much interest, can be evolved from the war game when the exercises are carried out in a practical spirit, and under skilful and experienced guidance. Those exercises are especially useful in exemplifying the action of the three arms where field practices are necessarily impracticable.

4th. The practice of attaching Officers of one arm temporarily to another arm has been tried in India, but not, I think, with conspicuous success. It has been left entirely to Officers to ask to be so attached, and we all in these matters require a little encouragement, not to say gentle pressure. General Owen, R.A., told us in this theatre, some three years ago, that in Belgium every infantry regiment is required to send a Captain to attend for fourteen days the artillery gun practice, and as there are seven of these courses annually, each regiment has seven Captains instructed every year, and he adds that the instruction was considered most valuable, as enabling the infantry Officer to appreciate the progress in artillery. I believe that our infantry Officers occasionally attend the practice camps at Okehampton and Shoeburyness, which is all in the right direction, but I think that the idea might be much extended. General Owen, in his lecture just referred to, also remarks to this effect, as follows:—

"It is sometimes said by Officers of other arms that artillery Officers endeavour to make a mystery of their arm, and this complaint has been echoed even by some artillery Officers. I have seen little to justify such a complaint. The details of gun and ammunition are rather complicated in these days, but it is hardly necessary for Generals or other Officers to master these. All they want is to know—what the fire of guns can do under various circumstances, the spaces batteries occupy in different formations, with a general idea of their tactics. To obtain the first it would be wise to give General and Staff, as well as other infantry and cavalry Officers, when practicable, the opportunity of visiting Okehampton, Shoeburyness, and other gunnery schools, and observe the practice there; and these Officers might make valuable suggestions respecting the positions of targets representing troops and in other matters."

5th. As regards the last of my proposals, viz., that of an examination in combined tactics for promotion to field rank, perhaps few will thank me for suggesting any addition to the present tale of bricks in the way of examinations; but the kind of examination here

cated is not one of books or papers, but a test of the knowledge of tactical principles and their application by a practical examination in the field, such as indeed is now carried out throughout India for all grades, and has been endorsed with the approval of even the examinees. Troops may or may not be employed, but an Officer is required to show on the ground how he would dispose a force of the three arms under certain suppositions, as, *e.g.*, an advanced or rear guard, a line of outposts, in defence of a position, &c.

There is still one more suggestion that I should like to make. It is one that was made to me yesterday in my journey from York, by an Officer with whom I was discussing this subject. It is a suggestion that has often presented itself to me, and, I have no doubt, to many of you, but it unfortunately involves a considerable initial outlay. It is simply the massing of troops of the three arms at certain tactical centres, instead of dispersing isolated units all over the country. This dispersion of regiments and batteries at small out-of-the-way places no doubt originated when railways were few and communication difficult, and telegraphs unknown, and was, I suppose, necessary in case of serious civil disturbance; but, with our present complete system of communication by rail, road, and wire, the necessity for such dispersion no longer exists. Its effect on higher military training is very prejudicial. How can a field battery, for instance, stationed at Exeter learn anything of its real duties in the battle-field? How can a cavalry regiment at Leeds fit itself for war service? How can an Officer who has never seen the three arms together, except, perhaps, at occasional manœuvres, and who finds himself in command of a mixed force in the field, do justice to himself or to his command?

No doubt but that any radical change in the quartering of troops in the United Kingdom would entail great expense, but much might, I think, be done by a gradual change without any overwhelming cost, and the object is one worth paying for, touching as it does so closely the war efficiency of our Army. What I have said as regards home applies with almost equal force to India, and could be there more easily carried into effect.

In conclusion, I would say that I shall feel well rewarded for the time given to this lecture if the points that I have had the honour to bring to your notice this afternoon should give rise to a useful discussion here, and to a thoughtful consideration of the subject afterwards.

Lieutenant-General Sir MARTIN DILLON: General Bengough's lecture is very interesting; it would be difficult to over-estimate the value of such lectures in preparing the mind for the field. Our Officers are exceedingly good, but labour under great disadvantages. Our organization hardly admits of the practical instruction of those who have field rank in moving the three arms, if, indeed, more than a battalion of two or three hundred men should be within their reach, before they succeed to the command of their regiment. Aldershot is the one place where troops are in sufficient number for the instruction of the superior Officers. The Curragh also, but at a certain period only, for whereas the battalions abroad are supplied from the oldest of our young soldiers, the effectives remaining are few indeed,

and they are absorbed in musketry training and in fatigue duties. Officers from the Staff College and those from regiments have passed through my hands—both classes equally defective in power, because without that practice which gives confidence. Practice is absolutely indispensable to fit them to handle the troops entrusted to them when acting under their seniors, and essentially for independent commands. Our own military literature is very limited in extent. Such a lecture as we have had the advantage of hearing goes far to supply that deficiency. I would gladly see General Bengough's suggestion carried into effect. I am sure that I but speak the sentiments of those who are present in offering him our best thanks for his paper.

FOREIGN SECTION.

THIS portion of the Number, hitherto the Occasional Notes, has now become the Foreign Section, and is reserved for articles, either original or compiled, on professional subjects connected with Foreign Naval and Military matters; also for notices of Professional Books, either Foreign or English.

The Council of the Institution wish that this section shall be developed still further, and I have undertaken to continue my Editorship during the current year, with a view of aiding them in carrying out this work. It seems to me possible to make this section, and consequently the Journal, the means of keeping our Members acquainted with all naval and military progress abroad *pari passu* with that progress; and I shall be glad to receive from members of both Services, including in the latter those of the Auxiliary Forces, suggestions, information, or offers of assistance.

It is desirable, further, that I should state that, as regards editing the Naval matter in the Section, I shall have the aid of Naval Officers, thoroughly competent to give good advice and to pronounce sound opinions.

It must, however, be borne in mind that, as the change from a quarterly to a monthly issue has been made in order to ensure the more prompt publication of the Lectures after their delivery than has hitherto been the case, the Foreign Section will, as a rule, be restricted in extent during the Lecture season in the first half of the year, and will be prominent in the second half.

It is requested that communications and books for review (the latter under cover to the Librarian) may be addressed to me at the Royal United Service Institution, Whitehall Yard, London, S.W.

LONSDALE HALE,
Colonel R.E. ret.

PRÉCIS OF THE INSTRUCTIONS FOR GUNNERY AND TORPEDO SCHOOL-SHIPS OF THE ITALIAN NAVY.

Translated from the "Giornale Militare per la Marina" by Commander H. GARBETT.

General Regulations.—The Gunnery School is established for the training of ordinary and higher-grade (*lit.*, picked) gunners, and also to complete the instruction of gunner-armourers and the non-higher-grade men, in order to afford them the opportunity of qualifying themselves for promotion.

The object of the school is to impart special instruction in military and technical subjects, and, in a minor degree, as far as the circumstances will permit, instruction in seamanship and the general education of the men are to be carried on.

A ship in the Reserve is to be used for the purposes of a school-ship, and she will be stationed at one of the seaports which is the headquarters of a naval command. There will be attached to her as tenders—

1. A vessel of the 2nd or 3rd class also in the Reserve, which, as far as possible, is to be armed with a full complement of guns of medium and light calibre; the final or supplementary course is to take place on board this vessel, from which also the target practice for both the ordinary and supplementary courses is to be carried out.

2. A tug in commission armed with small calibre and quick-firing guns.

3. Four steam pinnaces for ship's service and for exercise, and one for each tender.

The personnel and qualification of the Instructing Staff have been settled by the Royal Decree of the 4th June, 1891.

During the school course no changes are to take place among the Officers or Instructors; as far as possible they will be appointed for not less than a year, and only half will be changed at one time.

The school is placed directly under the command of the Senior Officer on the station; and all communications relative to the pupils and discipline of the school are transmitted to the Minister of Marine through the Senior Officer. With regard to the course of instruction and the carrying out of the studies and experiments of any kind, communications are carried on direct with the President of the Permanent Commission. The work on board the school-ship is carried on quite independently of the other ships and division of seamen in the harbour; moreover, she cannot take over the duties of Senior Officer or flag-ship.

All the regulations of the Navy are to be complied with on board the school-ship, so far as they do not clash with the present rules or

the special work of the ship. There are two ordinary courses yearly on board the school-ship, and two supplementary courses on board the tenders.

The first-named are intended for the instruction of gunners and the higher-grade men classed as skilled gunners. The second are intended to complete the education of other men, by affording them opportunities for qualifying for advancement to higher grades. Senior petty officers may also join in the final courses as ordinary scholars, in order to make themselves conversant with the new weapons.

The ordinary courses, which begin on the 1st of March and the 1st of September, last five months: the one month's interval between them is intended for repairs or any necessary work on board the ship.

The supplementary courses begin on the 16th of August and the 16th of February, and last four months.

During the month which precedes the beginning of a course, the men under orders for the course may be embarked upon the school-ship or tender, in order to receive their first instruction in seamanship. All the pupils must be on board for the beginning of each course, and, after it has commenced, no additional scholars can be embarked except by an order of the Minister.

The Instruction Board of the school-ship consists of the Commandant as President, the Seconds in Command of the ship and tender, and a Lieutenant-Commander as Secretary.

This Council is summoned by the Commandant to give their opinion on all matters which may arise in regard to the instructions; moreover, they have to compile the military instructions, and the annual recommendations as to changes to be made in the advancement rolls of the gunners. If the Commandant thinks fit, he can add one or more Officers to the Council for consultative purposes.

The Commandant nominates a special Commission to carry out investigations and experiments in all that concerns gunnery matters, which may be submitted to them by the Minister of Marine or the President of the Permanent Commission. All new instructions and changes must first be practically tested and approved by the Council, and for this purpose the Lieutenant-Commanders in charge of divisions are to be taken into consultation. The text of such compiled instructions and changes in the same are then to be transmitted to the President of the Permanent Commission.

Duties of the Personnel.—In addition to his duties as Captain of a ship, the Commandant of the school-ship, has the supreme supervision of and responsibility for the instruction of the men embarked on board the school-ship and tender, as well as for all experiments, trials, &c., which may have to be carried out.

The frigate Captain, Second in Command of the school-ship, in addition to his duties in that position, has special charge of the instruction and drills of both the ordinary and supplementary courses.

The corvette Captain, in charge of the general details of the ship, is responsible for the cleanliness and ordinary duties of the ship, and

that all matériel is kept in good condition. Under ordinary circumstances he has nothing to do with either the instruction or experiments, although in case of sickness or absence of the Second Commandant he performs his duties.

The Lieutenant-Commander who acts as Secretary of the Council is appointed for the purpose by the Minister of Marine; he has as his assistant one of the Sub-Lieutenants embarked for general duty on board the ship. Four Lieutenant-Commanders are entrusted with the instruction, superintendence and maintenance of discipline of the four divisions into which the men undergoing instruction in the ordinary course are divided; a fifth is embarked on board the tender, and performs the same duties for the men undergoing the supplementary course.

In addition to their duties in charge of divisions, the Lieutenant Commanders of the school-ship are on duty in turn for twenty-four hours as Officers of the day, and during that time are responsible for the carrying on of the ordinary duties of the ship. The Lieutenant-Commander of the tender has charge of all the gunnery and electrical stores.

All five are responsible for the general muster lists, punishment returns, and general register of the target and judging distance practices; a petty officer is told off to act as writer for each of these Officers.

To each division is attached a Sub-Lieutenant of the school-ship. These Officers are under the orders of the Divisional Commanders, attend all the drills and instructions of their men, are free from watch duties, but are on general duty for twenty-four hours in turn. The Sub-Lieutenants of the tender have the same duties to perform.

Four Sub-Lieutenants from the Seamen's Corps in barracks are also attached to the divisions, and perform similar duties to the above.

Four subordinate Officers from the Seamen's Corps keep watch-duties on board under the Officers of the day. Each of these Officers has, in accordance with the regulations for ships in commission, charge of a portion of the ship, and also the superintendence of a division of the regular crew of the ship.

The corvette Captain, Second in Command of the tender, has similar duties as the Second in Command of a ship whose Captain is absent on duty; he is under the immediate order of the Commandant of the school-ship. He superintends, subject to the Second in Command of the school-ship, the instruction of the supplementary course and the target practice of the ordinary course, which takes place from the tender.

The Chief Medical Officer of the school-ship has, in addition to his ordinary duties, the instruction of the men in affording first aid to the wounded.

The Commandant of the school has the power of selecting the petty officer and gunnery instructors from among the instructors of the preceding course, and from those petty officers who have passed through the supplementary course. He can, moreover, propose to the Commander of the Seamen's Corps that gunner petty officers attached

to the corps or detachments in port, who display special aptitude for the work, be embarked as instructors for the school. The petty officers instructors, in addition to their share of the instruction, will have to perform the duties which fall to them on board ordinary ships in commission. The school Commandant will recommend to the corps Commandant, at the end of the course to be marked first for promotion, such petty officers who may show themselves particularly industrious and meritorious in the performance of their duties; provided they stand for seniority among the first third of their grade. The gunner petty officers detailed as under-instructors and those gunners selected as assistants are chosen by the Commandant, and are subject to the same regulations for duties and recommendation for promotion as given above.

The superior petty officers for quartermaster and deck duties, who are embarked on board the school-ship and her tender according to complement, are detailed as signalling and seamanship instructors. They have charge of the seamanship instruction and the signalling school in addition to the ordinary duties appertaining to their grade.

The petty officers, gunner petty officers, under and assistant instructors are to assist in the instruction in the Elementary School, and they will draw the extra pay laid down in the Royal Decree of the 4th June, 1891.

Members of the staff and crew not mentioned in the foregoing regulations will perform their duties on board the school-ship and tender as on board any other ship in commission.

A draughtsman from the Gunnery and Torpedo Department at the Ministry of Marine will also be embarked on board the school-ship; should others be required, a demand is to be made for them to the Ministry.

The Ordinary Courses.—The number of pupils will be settled by the Ministry of Marine. A Lieutenant-Commander of the school ship takes part in the Commission, which, under the presidency of the Commandant of the Seamen's Corps, chooses the pupils from among the seamen. There take part in the ordinary course—1st, able seamen, who are picked out by the above-named Commission; 2nd, boys from the Training School, who are not less than seventeen years old; 3rd, the volunteers enrolled for service as gunners; 4th, those gunnery and torpedo factory apprentices who, from want of requisite mechanical knowledge, are rejected from the schools of those departments, provided they are not less than seventeen years old. Men who have less than three years' active service to complete are not allowed to join the school.

Active men of strong constitutions, good eye-sight, and corresponding intelligence will be those selected for the school courses; the boys from the Naval School must possess a physical development in accordance with their age. Those seamen who were mechanics before joining, and such who can read and write well, or who apply to go through the course, will be selected by preference.

The Commandant of the school-ship is empowered to send back to the Seamen's Corps all those who do not appear likely to develop into

good gunners. Moreover, the Officers commanding divisions are, at the end of the first month of training, to place before the Commandant a list of those who they do not think it advisable should continue the course.

The ordinary courses are divided as under:—

Course A, which commences on the 1st March, and ends on the 31st August.

Course B, which commences on the 1st September, and terminates on the 31st January.

These courses can again be subdivided into as many periods as the Commandant may consider convenient or the Council recommend.

The method of instruction and of the drills is laid down in the military regulations; the theoretical portion of the first is to be limited to general details and principles. The instruction is imparted in accordance with the programme laid down for the classification of the men as gunners and skilled gunners, special pains being taken over the elementary instruction of the pupils. Instruction time is to last on an average six hours a day. Holidays and Saturdays are excepted, the general cleaning of the ship taking place on the latter day. In the summer the men receive swimming lessons. The target practice during the course is settled by the Commandant, on the advice of the Council of Instruction.

At the end of each instruction period, the Divisional Commanders lay before the Commandant the general roll, in which is recorded the progress of each scholar. Twenty points are the highest marks; the "nil," absolute ignorance. At this time the Commandant and the Council have to be present at the drills of each division.

Each Divisional Commander has at the end of the ordinary course, after the examination of the pupils, to complete the general roll, which also shows the results of the target practice and the conduct of the men, and he then lays it before the Commandant. On the basis of the return the men are classified by the Council, assisted by the Divisional Commanders. Men who have less than 10 points are not qualified; those with from 10 to 15 points receive the rating of gunner; those with over 15 points are classed as higher grade or skilled gunners.

The men who have qualified are immediately redrafted to the Seamen's Corps. The Commandant of the school-ship can withhold the certificate of men of bad character, forwarding it to the corps Commandant, who keeps back the advancement of any such men until they have been favourably reported on for at least six months on board a ship in commission. The men can also receive, according to their efficiency, certificates as signalmen, and as captains of guns.

The Second Commandant has, on the making out of the men's certificates, to make any remarks which he may think necessary, laying stress on such points as whether a man is a skilled signalman, whether he has profited sufficiently by the doctor's lessons to be able to afford first help to the injured, whether he possesses special qualifications as a marksman and captain of a gun, and finally, if his certificate should be withheld for misconduct.

After the striking off of men who on trial are considered as unfit to go on with the course, no other pupils are to be disembarked, except by special order of the Minister, unless it be for punishment or sickness.

The Final or Supplementary Course.—Those qualified to take part in this course are:—1st, the men who have taken certificates as skilled gunners in the ordinary course, and who seem likely to obtain at the end of the supplementary course a certificate of competency for petty officers; 2nd, the gunner armourers who come from the Technical School at San Vito; 3rd, the gunner armourer pupils from the school at San Vito who are not classified as armourers, not having displayed the requisite technical knowledge in their examination; 4th, Those men, classed as gunners, who are sent as pupils from the Seamen's Corps, in order to fit themselves for examination for advancement, or to make themselves acquainted with the newest equipment.

The supplementary courses are divided as follows:—

Course C, which begins on the 16th August and ends on the 15th December.

Course D, which, beginning on the 16th February ends on the 15th June.

Each course is subdivided into two periods as under:—

Course C	1st period,	16th August to 15th October.
	2nd „	16th October to 15th December.
Course D	1st period,	16th February to 15th April.
	2nd „	16th April to 15th June.

The scholars of the supplementary course are divided into three classes:—1st, the gunner armourers and armourer pupils who come from the school at San Vito; 2nd, the skilled gunners; 3rd, the petty officers. At the end of the first month those skilled gunners who do not show sufficient capacity are struck off and sent back to their corps, their certificate of qualification as skilled gunner being forfeited. The Commandant of the school is empowered to strike off and disembark any man who shows a want of zeal in his studies, or is badly reported on.

The course of study is so arranged that each pupil is worked up in the subjects necessary for his advancement. The target practice during the course and the regulation of the studies are settled by the Commandant in consultation with the Council. In the summer all the men have to attend the Swimming School; the ordinary duties of the ship are carried on as on board the school-ship during the ordinary course.

At the end of the supplementary course all the men who have been under instruction have to undergo an examination according to an established scheme, for advancement to a higher grade. Certificates for competency in signalling, as well as for special skill as captains of guns, will also be given. Copies of the results of the examinations are forwarded to the Ministry of Marine, and to the headquarters of

the Seamen's Corps. At the completion of the course, the men who have taken part in it are disembarked, except those who are selected to act as instructors or assistant instructors for the ensuing ordinary and supplementary courses.

The Second Commandant of the tender fills up the certificates of the pupils and submits them, with his remarks, to the school Commandant.

Twice a year, that is to say, at the end of the supplementary courses, an Examination Board, under the presidency of the Commandant of the school, examines those gunners who are not embarked on board the school-ships, but who are present in port and are anxious to pass for promotion. Men who are embarked on board ships in commission and are absent from the seat of the school are examined on board their ships. A special report can always be made of those gunners who qualify themselves for the higher grade, though not embarked for the course; the points they obtain according to the system of marking laid down in the school-ship being mentioned in the report.

Men who pass the examination for promotion receive a certificate of competency, which holds good for three years; if at the end of that time they are not promoted they are required to pass again.

Expenses of the School.—The school has its own expense department independent of the ship's administration and ship's cash chest.

For each scholar in the course there is an allowance of half a lire a month, out of which the following charges are defrayed:—Office stationery and necessaries for the elementary and evening classes; military circulars, which are issued free to the instructors; books for the school library, and yearly subscriptions for service technical journals, and others relating to technical experiments; special registers and printing for the school; supply of books and papers to the men's library; a premium of 50 lire and under for instructors who have specially distinguished themselves during the course. Fines inflicted on the instructors for breaches of discipline are thrown into this fund. The Administration is allowed a fund, which is not to exceed 50 lire a month, for unforeseen expenses. The fund is managed by the Council, who are allowed the assistance of a clerk.

The Archives and Library of the School.—The archives of the school are kept in accordance with a regulation of 30th August, 1865. In addition are kept: register of the minutes of the Council of Instruction, of all experiments carried out, of the classification of the men who pass through the school, of the gunners and petty officers who have taken part in the supplementary courses, and other registers relating to the work of the school. All books bought for the ship form part of the library, as well as all plans and models; the ship's library is joined to the school library.

The Examination Board vote first in secret, using white and black balls over the passing or rejection of candidates, then openly over their classification; the points from 0 to 9 constitute rejection, from 10 to 20 competency.

The Torpedo School-ship.

General Regulations.—The object of the school is to train a corps of skilled torpedoists and torpedo-electricians, also to give opportunities to men who wish to qualify for advancement. A ship in the Reserve is used as the school, and is stationed at one of the ports, which is the headquarters of a naval command. Attached to her as tenders are:—1st, a ship of the second or third rank also in the Reserve, armed with quick-firing and light guns, and also supplied with all the prescribed electric fittings and lighting and torpedo-tubes; 2nd, a torpedo-boat flotilla, consisting of two sea-going torpedo-boats, a 1st-class coast torpedo-boat, a 2nd-class coast torpedo-boat, and one of White's torpedo steam pinnaces; 3rd, a tug in commission, fitted, if possible, with quick-firing and light guns, and also electric light apparatus; 4th, four steam pinnaces fitted for exercising with the electric light and spar torpedoes, and for firing machine-guns and guns of small calibre; 5th, four rafts for laying out submarine mines; and, lastly, four pinnaces fitted for diving apparatus. The torpedo-boat flotilla is manned by men from the school-ship, who receive extra pay.

The regulations detailing the duties of the Officers, petty officers, and men, the teaching staff, the number, length, and commencement of the courses, and the duties of the Council of Instruction are identical with those for the Gunnery Ship.

There are two ordinary courses and two final courses, which commence and end on the same days as the gunnery courses, and are similarly divided and subdivided.

The Ordinary Courses.—The number of pupils is settled in accordance with the requirements of the Service by the Ministry of Marine. The men are selected from the Seamen's Corps by the Committee of Officers which select those for the Gunnery School. The men who take part in the courses are:—1st, the seamen selected by the Committee; 2nd, boys from the Training School who have been selected for the torpedo service, and are over seventeen years old; 3rd, volunteers who have joined the torpedo service; 4th, those gunnery and torpedo factory pupils who have been rejected by the technical schools, for lack of sufficient mechanical knowledge, and who are not less than seventeen years of age. Men who have less than three years' active service to complete are excluded from the school. The regulations for the ordinary course are analogous to those for the gunnery course already described.

The Lieutenant-Commanders in charge of divisions are responsible for the following registers being kept:—1st, the general muster roll of their divisions; 2nd, a register of firing and target practice; 3rd, a journal of practice with the Whitehead torpedo; 4th, a journal of the exercises in diving. A petty officer is placed at their disposal to act as clerk.

In the last month of each course the more advanced scholars are instructed in, and practised with, the search lights.

The course of submarine mining takes place in the interval between the two ordinary courses, and lasts a month. The efficiency of each

torpedoist in this branch of his work, who attends the course, is noted on his certificate.

The Supplementary Course.—Those who are selected for this course are:—1st, pupils of the ordinary course who have been classified as skilled torpedoists, and who are expected to be able, at the end of the final course, to obtain a certificate of qualification for petty officer; 2nd, the torpedo artificers and torpedo electricians who come from the school of San Bartolomeo; 3rd, those scholars from San Bartolomeo who are not classified as torpedo artificers or electricians from want of the necessary technical knowledge; 4th, those torpedoists who are detailed from the headquarters of the Seamen's Corps either to qualify themselves for advancement or else to make themselves acquainted with all the latest improvements.

The other regulations for this course, as well as for the examinations and the duties of Examination Board, are identical with those for the Gunnery School already described.

There is an allowance of 1 lire for each scholar monthly, towards the expenses of the school. The regulations for the archives and library are similar to those in the Gunnery Ship.

INSTRUCTIONS FOR THE SWIMMING OF CAVALRY.

(*Provisionally issued for the Guidance of the German Cavalry.*)

CAVALRY should be able to cross any streams that may be met with. In the case of large rivers, in which long distances have to be swum, this will only be possible for the mass of the cavalry if they have the aid of boats. Still, every endeavour should be made to have in each squadron a certain number of patrols which, lightly armed and carrying only a light kit, would be able to cross even broad streams without assistance, and, having arrived on the further bank, could continue their march without delay.

For both kinds of passage, it is necessary that some of the men should be able to swim. A squadron which has no men who can swim, cannot successfully undertake swimming exercises for the horses, whether with or without boats. Only a man who knows that he can easily reach the bank in case he has to leave his horse or the boat in mid-stream,[1] will act intelligently and with confidence in a boat or on a swimming horse.

Considerable stress must, therefore, be laid on the instruction of the men in swimming. In most cavalry stations, the small pieces of water necessary for this can be found ready for use, or may be made of the required depth. A sufficient number of men must also be instructed in rowing, punting, and steering a boat. This instruction, as well as that in swimming, may replace gymnastics during the hot summer months.

Independent Swimming of Horses.

The most important preparation of horses for the passage of all kinds of streams consists in inspiring them with perfect confidence when going into deep water. It is only by constant exercises with this object in view that it is possible to remove the tendency to lose their heads, to which many horses are subject when in the water. All horses can swim without further instruction, or, at any rate, they learn to do so in a very short time. The safest method of swimming, and the one by which the desired object is most quickly attained, is that in which the greatest freedom is given to the horses. Thus,

[1] In the broadest rivers which have to be taken into consideration, a man would have to swim at the most 500 metres from the middle of the stream to the bank, the current being taken into account. A man can swim 100 metres in three minutes. Experience shows that sometimes even good swimmers suddenly lose heart in mid-stream from want of confidence, and then sink as if paralysed. The confidence of the men must therefore be increased by training as many long-distance swimmers as possible, *i.e.*, men who can swim for half an hour at a stretch.

teaching a horse to swim consists in taking away his fear of water by having a good swimmer in the water with him. A good current in deep water is in this case advantageous, as it has been found by experience that horses, when they perceive the strength of the current, more readily give up resistance, and the current renders swimming easier.[1] As soon as a horse gets out of its depth, it swims straight to the front, so that it is only a matter of placing the horse's head in the direction in which it is to swim. The best way of guiding a horse is to knot the bridoon reins short,[2] the knot being placed on the middle of the mane. The swimmer, lying extended horizontally close to the horse on the up-stream side of it and holding on to its mane, allows himself to be towed by it, and by lightly feeling the near or the off rein as may be necessary with his free hand, holds its head in the direction required. Provided the aids are properly applied, resistance on the part of the horse to the feeling of the reins is hardly possible; but, if necessary, the horse may be given a blow on the cheek with the flat of the hand. In this way a good swimmer can guide any horse in the required direction if it be out of its depth, *i.e.*, from the moment it is obliged to swim; and previous to this point, the ordinary *aids* are all that is required. This is also the time for the rider to slip off his horse, which should not be done too soon or too late. The struggle which sometimes takes place (generally in consequence of badly applied aids) with a horse that may try to get back to the bank, has no danger for either party; if they separate, both reach the bank by swimming. Kicks in deep water hurt the swimmer as little as a short ducking hurts the horse. At the very first attempt, endeavour should be made not to allow the horse to have its own way. With particularly obstinate animals, it is advisable to employ different riders in order to attain the object in view.

When teaching a horse to swim, it should not be ridden while swimming, as the rider, clinging close to it and weighing heavily on its hind quarters, destroys its equilibrium, and the horse is liable to turn over or fall on one side. On actual service, even a man who cannot swim may be compelled to take to the water and trust for safety to his horse, the latter swimming in the general crowd and the man holding on to its mane.

Swimming Horses by Guiding them from a Fixed Point.

(*a.*) *By means of a rope from a boat or from the further shore.*—This method is, as a rule, to be employed only in swimming exceptionally refractory and obstinate horses, as well as when good swimmers are not to be had.

The rope, not a forage cord, must be used double without knots or loops, and passed through the head-collar ring, so that, by letting it slip through the ring, it may at once be let go. It is best to let the horse go free as soon as it gets into mid-stream, and has taken the

[1] On the other hand, practice in swimming in still water is quite sufficient to enable a horse to swim safely across rivers with strong currents.

[2] The bit should always be removed when the horses are swum.

direction of the further shore. The rope used should not exceed 20 or 30 yards in length, as otherwise it hangs down in a curve on account of its own weight, and when the rope is pulled, the horse's head is dragged under water.

(*b.*) *By the rider leading them close to a boat by means of the bridoon rein or a forage cord*[1] *passed through the head-collar ring, the rider sitting as low as possible in the boat.*—This method of swimming horses, as well as the preceding one, is only to be used when good swimmers are not available or not in sufficient numbers. Towing the horse after the boat is no assistance to it, but rather a hindrance, as it has to swim just the same as if it were free, but must regulate its pace according to that of the boat. It frequently happens, when swimming a horse by means of a boat, that the horse, in consequence of the force to which it is subjected, gives up swimming altogether, lays itself on its side, and allows itself to be towed along as if it were paralysed.

In actual practice, the most usual method of getting a body of cavalry across streams will be that of swimming the horses with boats. The disadvantage of hindering the swimming of the horse is more than compensated by the advantage of conveying the rider and his kit across without their getting wet. When crossing narrow, or only moderately broad streams (say 50 yards wide), it is advisable to use the boat as a ferry-boat, working on a double rope stretched across the stream. The boat, pulled by two men, one standing forward and the other aft, can, even with a fairly rapid current, be kept in the required direction; its rate of movement can be regulated to suit that of the horse, which is held by the bridle, so that the disadvantages of swimming the horses with boats, above-mentioned, to a great extent disappear. In order to accelerate the crossing of the men with their kits, and the subsequent saddling, it is imperatively necessary that the articles of each man's kit should be tied together and then placed in the boat by troops and ranks. The unloading will be carried out in the same orderly manner, on the spot which is chosen as the saddling place, which must not be too near the landing place of the horses.

In order to ensure the passage being conducted in a calm and orderly manner, strict discipline must be enforced, the materials and means at disposal must be judiciously and properly employed, and non-commissioned officers and men told off for special duties.

(*c.*) *By guiding the horses from a foot-bridge.*—In this case it is best to guide the horse by a lance, the sling of the lance being unbuckled and made fast to the bridoon rein, as near as possible to the butt end of the lance. The rider, walking on the foot-bridge, can in this way regulate his pace to suit that of his horse, and can at the same time prevent any attempts at landing on the bridge. On the hither bank, one man leads the horse, if necessary, holding it on the further side until it gets into deep water, so as to prevent the horse

[1] The man holds both ends of the forage cord in his hand, and in case of necessity lets go the end which has no loop, and draws the cord through the ring.

being refractory, backing or rushing forward, as long as it is in its depth; as soon as it swims, it must be guided entirely by the man who controls its head. In the field, when a large number of horses have to cross, as in the passage of a regiment, brigade, or division, it is advisable to construct a foot-bridge. For the passage of a squadron or any smaller body of cavalry, it will often not be worth while to spend the time necessary for doing this, and the method described in (3*b*) will be more advantageous. For the passage of larger bodies by the aid of a foot-bridge, it is best to drive the horses *en masse* through the water, one horse, guided by a lance, leading the way, provided that the further bank is not unsuitable for securing the horses again. In such cases, the several squadrons are brought up to the crossing place and unsaddled there. The men put on their forage caps, take off their swords, and fasten them to the saddles by passing the girths and stirrup leathers round them. Having been told off by threes, Nos. 2 place the blankets on their heads, just as they were when on the horses, and hang their helmets on one arm; Nos. 1 and 3 then place a saddle on the head of No. 2, which is protected by the blanket.

The passage of the horses must not begin until all the saddles have in this way been placed on the opposite bank.

Loading the Horses when Swimming.

Although horses are not able to carry riders for any considerable distance when swimming, still loading, to a certain extent, is admissible. Most horses can easily carry the saddle and blanket without any special practice. The danger of their being weighed down by the wet blanket has but seldom been noticed. As the mess-tin is light enough to float of itself, it may be left attached to the saddle, as also may be done with the forage cord. It is quite different, however, with the rest of the kit; the best swimming horses can hardly keep above the surface for more than a minute when loaded with it. A considerable part of the weight does not lie near the back, but is fairly high up, so that the horse, when out of its depth, easily loses its balance, falls on one side, and is then lost; even when brought close to the bank by means of a rope, horses which have once fallen on their sides can only be got in an upright position again with difficulty, on account of the kit being thoroughly soaked. Horses swimming with the whole kit, turn over most easily in a current; on the other hand, in streams where there is no current, they can swim for very short distances with the full kit, as the water penetrates the latter but slowly.

From this it appears that a stream of some depth and breadth cannot be crossed by a closed body of cavalry without the aid of boats. But single riders (patrols) can swim across them after having taken the heavy part of the kit from their horses and distributed it among the nearest files. It is important that these quick distributions of kit should be practised.

Loading the Rider while Swimming.

The cavalry soldier, who is a good swimmer, can accompany a horse which swims well across a broad stream with full equipment, and, after a little practice, even with a lance.

The horse can easily carry the helmet, sword, and boots, the chief hindrances to the swimmer, as well as the rider, who holds on to its mane. In this case the only danger is when the swimmer parts from his horse. A strong swimmer, fully equipped, will even be able to keep up for some time apart from his horse, and to reach the nearest bank; this he will do most easily in a current, by swimming in a slanting direction. But in order to obviate the danger to which almost all men are liable, viz., the possibility of being separated from their horses even when the latter swim freely, they should always be lightened as follows during exercises in time of peace:— The boots are to be taken off and fastened with the tops downwards, one on each side of the front arch of the saddle, the sword is to be fastened to the rear arch of the saddle, and the forage cap is to be worn instead of the helmet, &c.

On the other hand, the men must be practised in carrying the carbine slung over their shoulders, the sling passing under the shoulder straps, &c.; the rolled cloak will remain on the rider, and carbine and blasting cartridges be put in the trousers' pockets.

It is understood, as a matter of course, that in exercises of this sort, special precautions are to be taken, such as providing boats, &c.

NOTICES OF BOOKS.

Almanach der Kriegs-Flotten, 1892. *Separatausgabe der Allgemeinen Theile aus dem "Almanach für die k.u.k. Kriegsmarine*, 1892." Wien: Gerold & Co. Pp. 252. Size 5″ × 2½″ × ½″. Weight under 6 ozs.

Aide-Mémoire de l'Officier de Marine. Par MM. DURASSIER et VALENTONS. 5me Année, 1892. Paris: Baudoin. Pp. 539. Size 6½″ × 4″ × ¾″. Weight under 12 ozs.

Le Scuole di Marina all' Estero e in Italia. Par DANTE PARENTI. Roma: Forzani, 1891. Pp. 267. Size 9″ × 6½″ × ½″. Weight under 1 lb.

The Naval Annual, 1892. Edited by T. A. BRASSEY. Portsmouth: Griffin, 1892. Pp. 575. Size 9¾″ × 6½″ × 1½″. Weight under 3 lbs. 4 ozs. Price 12*s.* 6*d.*

Lord Brassey will forgive us for having placed the sixth annual issue of his book in the same list with three other books with which it has only one feature in common, that of being a work of reference with regard to foreign navies. The subjects and the writers in the "Naval Annual" are as follows:—"Progress of British Navy, 1891-92," by the Editor; "Progress of Foreign Navies, 1891-92," by E. Weyl; "British Naval Manœuvres," by J. R. Thursfield, who contributes also the chapter on "Foreign Naval Manœuvres"; "Descriptions of the Ships Building or Completing," by F. K. Barnes; "Marine Engineering," by R. C. Oldknow; "Royal Naval Exhibition," by H. O. Arnold Forster; "Chilian Civil War," by W. Laird-Clowes. Part II, by Mr. Barnes, contains "Tables and Plans of British and Foreign Armoured and Unarmoured Ships." Captain Orde Browne, in Part III, deals with Armour, Ordnance, and Quick-Firing Guns. Part IV contains a great number and variety of Statistics, Official Statements, and Figures, compiled by Mr. Laird-Clowes; and in Part V, Lord Brassey himself treats of Manning and Training, Shipbuilding Policy, and Navy Estimates.

Architecture Navale. Théorie du Navire. Par MM. J. POLLARD et DUDEBOUT. Tome III. "Dynamique du Navire: Mouvement de Roules sur Houle; Mouvement Rectiligne Horizontal Direct (Résistance des Garenes)." Paris: Gauthier-Villars et Fils, 1892. Pp. 523. Size 9¾″ × 6¼″ × 1″. Weight under 2 lbs. 8 ozs. Price 12*s.*

Elektrotechnischer Unterricht und Anleitung zum Betriebe elektrischer Anlagen insbesondere auf Kriegs-Schiffen. Von M. BURSTYN. Pola: Gerold's Sohn in Wien, 1892. Pp. 234. Size 9½″ × 6¾″ × ½″. Weight under 1 lb. 2 ozs. Price 4*s.*

Die Schiffs-Station der k. und k. Kriegs-Marine in Ost-Asien. Reisen S.M. Schiffe "Nautilus" und "Aurora," 1884-88. Von VON BENKA. Gerold's Sohn, Wien, 1892. Pp. 990. Size 9¾″ × 6¼″ × 1¼″. Weight under 3 lbs. 4 ozs. Price 12*s.*

Barracks and Battlefields in India; or the Experiences of a Soldier of the 10th Foot (North Lincoln) in the Sikh Wars and Sepoy Mutiny. Edited by the Rev. CÆSAR CAINE, with a preface by Major-General Sir H. M. HAVELOCK-ALLAN, Bart., V.C., M.P. York: Sampson. London: Kelly, 1891. Pamph. Pp. 131. Price 1*s.*

Rulers of India. Mountstuart Elphinstone. By J. S. COTTON, M.A. Clarendon Press, Oxford, 1892. Pp. 222. Size 7½″ × 5″ × ¾″. Weight under 14 ozs. Price 2*s.* 6*d.*

The biographer tells us that "on the long roll of civil servants of the East India Company, no name possesses a greater charm than that of Mountstuart Elphinstone." His Indian career extended from 1796 to 1827. "As a diplomatist and administrator, he exercised a decisive influence upon the fate of Western India, at the critical epoch when British order had to be substituted for Marathá turbulence; his memory is still revered in Bombay—by English and natives alike—for nobility of character, justice, and encouragement of education; his 'History of India' has won for him a permanent place in literature. Elphinstone's long life witnessed almost the entire drama of British conquest." These quotations are followed by other statements, no doubt correct, of a similar character. The prologue raises the expectations of the reader, and these expectations are hardly fulfilled, but no doubt this is due to the condensation which the biographer had to effect in order to bring into a sketch the great career of a great man.

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N.B.—These numbers do not comprise those who qualified at the Sandhurst Examination.

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Place.	Name.	Marks.	Place.	Name.	Marks.
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6th ...	W. C. C. Ash	1,890	20th ...	E. C. F. Wodehouse ...	1,825
7th ...	C. B. Prowse	1,887	24th ...	W. Marriott Dodington	1,806
8th ...	J. C. Mack	1,886	27th ...	E. G. T. Bright	1,795
9th ...	C. D. Christopher ...	1,881	29th ...	T. K. Gaskell	1,792
	A. R. C. Savile	1,881	34th ...	H. S. Scott Harden ...	1,751
13th ...	A. J. Lean...	1,876	*42nd ...	C. H. Pringle	1,709
15th ...	D. J. Propert	1,858		ARTILLERY.	
	CAVALRY.		4th ...	B. W. Holman	1,942
*9th ...	M. M. Litkie	1,865			

* Prepared at the Country Branch.

In addition to the London Classes, a Country Branch for resident and non-resident pupils has been opened for the Militia Competitive at Camberley, under the personal superintendence of Lieut.-Col. W. R. Fox, late R.A. (Honours) Staff College, assisted by Lieut.-Colonel Cooper King, late R.M.A. 1st Staff College.

The CIVIL STAFF embraces Thirty-three Gentlemen, of whom Twenty are University Graduates in high honours. The Military Staff includes Twelve Officers, of whom Five are Staff College Graduates in honours. The total number of Forty-five is far larger than will be found at any other establishment in England, and is sufficient to give that individual instruction to the pupils to which the above remarkable successes are due, and which for many years past have exceeded the results of any other tutor or school.

Captain James can be seen daily at twelve noon.

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